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VOL. CLIV.—No. 4002] LONDON: FRIDAY EVENING, SEPTEMBER 23, 1932 [PRICE ONE SHILLING BY INLAND POST 1s. 2d.

PUBLIC NOTICES.

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 11th October, 1932, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at the Employment Exchange, Sheffield.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender, may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W.1, on payment of One Pound. (Cheques payable to The Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 8983

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 13th October, 1932, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at (1) Stamford Hill, N., Telephone Exchange; (2) Bradford, Yorks., Employment Exchange.

Drawings, specifications, copies of the conditions and forms of contract, bills of quantities and forms for Tender, may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W.1, on payment of One Pound in each case. (Cheques payable to The Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 8989

Northampton Polytechnic INSTITUTE, ST. JOHN-STREET, LONDON, E.C.1.

SCHOLARSHIPS IN ENGINEERING.

An EXAMINATION will be held on SEPTEMBER 27th and 28th at the Polytechnic for the award of the following Scholarships:—

THREE SCHOLARSHIPS IN ENGINEERING.

These Scholarships are tenable at courses extending over four years in Civil, Mechanical, Electrical or Aeronautical Engineering, and include 10 months' practical experience in the works of large industrial firms.

The Scholarships are equal in value to the London scale of fees.

For further information apply to S. C. LAWS, M.A., M.Sc., Principal. 8932

Bengal Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for:—

700 STEEL CARRIAGE AND WAGON TYRES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C.2, on or after Monday, 19th September, 1932.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Tuesday, 4th October, 1932.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board, R. GRANT, Secretary. 8979

Bengal Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for:

2500 BOILER TUBES.
1000 SUPERHEATER FLUE TUBES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C.2, on or after Thursday, 22nd September, 1932.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than NOON on Tuesday, 11th October, 1932.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board, R. GRANT, Secretary. 8990

Borough of Wallingford.

PUMPING PLANT.

TENDERS are INVITED for the SUPPLY, DELIVERY, ERECTION, and SETTING TO WORK of a TREBLE-RAM PUMP, together with all ACCESSORIES thereto to make the same complete, at the Waterworks Pumping Station in Station-road.

An alternative TENDER for a PUMP of the Centrifugal Type will be considered by the Council.

The capacity of the pump to be 10,000 gallons per hour.

Copy of particulars may be obtained from the Engineers, Messrs. Piddian and Deeley, 13, Church-street, Stourbridge, or the undersigned.

Sealed Tenders, endorsed "Tender for Pumping Plant," to be delivered at my office not later than Saturday, 8th October.

The Council do not bind themselves to accept the lowest or any Tender.

FRANCIS R. HEDGES, Town Clerk.

Wallingford, Berks., 19th September, 1932. 8978

London County Council.

TENDERS are INVITED for the SUPPLY, DELIVERY, and ERECTION of an IRONING MACHINE at Hammersmith Hospital, W.12.

Specification, form of Tender, &c., may be obtained on application to the Chief Engineer upon payment of £1 by crossed cheque or order payable to the London County Council. (NOTE.—CASH WILL NOT BE ACCEPTED. This amount will be returnable only if a bona fide Tender has been sent in and not subsequently withdrawn. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the CHIEF ENGINEER (C.), The Old County Hall, Spring-gardens, S.W.1. Personal enquiries at Room 2, No. 3, Warwick House-street, Cockspur-street, S.W.1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E.1, after 4 p.m. on Monday, 10th October, 1932, will be considered.

The Council does not bind itself to accept the LOWEST or any Tender. 8980

The Engineer

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PUBLIC NOTICES.

Bombay, Baroda and Central INDIA RAILWAY COMPANY.

RECONSTRUCTION OF THE NEERBUDDA BRIDGE AT BROACH, BOMBAY PRESIDENCY, INDIA.

The Directors are prepared to receive up to 11.30 a.m. on Monday, 5th December, 1932, TENDERS for the above WORK.

The bridge will consist of 15 spans of 282ft. effective plus one span of about 247ft. plus an approach plate girder span of about 60ft., designed to carry two tracks of the India Broad-gauge Heavy Mineral Standard loading. The piers will consist of twin reinforced concrete cylinders, 22ft. in diameter, founded at about 110ft. below mean water level.

For the purposes of tendering the work has been divided into 3 Schedules as under:—

SCHEDULE I. (A).—Manufacture and Delivery, F.O.R. Broach or F.O.B. Port of Shipment, of Steel Work in Well Curbs, Cylinders and Grillages, about 1747 Tons.

SCHEDULE I. (B).—Manufacture and Delivery, F.O.R. Broach or F.O.B. Port of Shipment, of Steel Work in Spans, about 11,400 Tons.

SCHEDULE II.—Taking Delivery at Broach of Steel Work in Well Curbs, Cylinders and Grillages. Erecting and Pitching Cylinders, Well Sinking and Construction of Piers in Concrete (about 60,000 Cubic Yards), including Reinforcements.

SCHEDULE III.—Taking Delivery at Broach of and Erecting Steel Work in Spans, about 11,400 Tons, including Painting.

Tenders may be submitted for any one of the Schedules I (A), I. (B), II., or III. separately or for any combination of them or for the whole work.

Tenders must be made on forms, copies of which, with specifications, can be obtained at these offices on payment of £1 each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG, Secretary.

Offices: The White Mansion, 91, Petty France, Westminster, S.W.1. 16th September, 1932. 8975

SITUATIONS OPEN.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

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PUBLIC NOTICES.

PATENTS AND DESIGNS ACTS, 1907 TO 1928.

Notice is Hereby Given that ARTHUR BROUGHTON BROUGHTON-EDGE, of Australia House, Strand, London, W.C.2, SEEKS LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 364,085 granted to him for an invention entitled "Improved Apparatus for Determining the Nature of the Sub-soil and for Detecting the Presence of Minerals, Metals or Metalliferous Deposits."

Particulars of the proposed amendment were set forth in No. 2277 of the Official Journal (Patents), published on 7th September, 1932.

Any person, or persons, may give Notice of Opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C.2, within one calendar month from the date of publication of the said Journal.

W. S. JARRATT, Comptroller-General. 8977

PATENTS AND DESIGNS ACTS, 1907-1928.

Notice is Hereby Given that FREDERICK THOMAS BERSEY, ERNEST ARTHUR HARDY, SIDNEY CHARLES NEWSON, and THE LAYSTALL MOTOR ENGINEERING WORKS, Ltd., all of Laystall House, Ewer-street, London, S.E.1, SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 372,401, granted to them for an invention entitled "Improvements relating to the Metallic Lining of Metal Bodies."

Particulars of the proposed amendment were set forth in No. 2277 of the Official Journal (Patents), published on 7th September, 1932.

Any person, or persons, may give Notice of Opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C.2, within one calendar month from the date of publication of the said Journal. 8984

SITUATIONS OPEN (continued).

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The Engineer

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Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

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Noise in Industry.

IT is frequently asserted that noisy conditions affect human efficiency adversely, but, according to a report issued last Monday by the Industrial Health Research Board, the degree of disturbance has been much exaggerated. A number of experiments were carried out with the aid of eighty Cambridge undergraduates to determine the effect of noise when various manual and mental tasks were to be performed. The tasks were divided into three classes, an eye-maze or sensorial, a "guidit" or predominantly motor test, and a card-sorting test, which combined the two. The efficiency was found to be lower in noisy conditions and with vibrations than under silent conditions, if only the first part of the working spell was taken into account. In every case, however, adaptation took place after a comparatively short time, and the task was performed with inappreciably affected efficiency. It is interesting to note that a corresponding drop in initial efficiency was observed when work was resumed under silent conditions, so that the change had more direct effect than the nature of the conditions. Where a test involving mental concentration was concerned, the effect of gramophone records, conversational and humorous, was found to make the task more difficult. Two conclusions, according to the report, appear to be established—loud noise is, in general, prejudicial to efficiency and its harmfulness is roughly proportional to the difficulty of the work involved; but, nevertheless, the psychological and physiological effects due directly to noise have been, and constantly are, greatly exaggerated in more or less popular writing.

British and Foreign Destroyer Speeds.

ON more than one occasion phenomenal trial speeds made by destroyers constructed by Continental builders have been mentioned in our pages. It is quite well known that the velocities referred to have in some cases been attained under trial conditions of load not in accordance with British Admiralty practice, and in uninformed circles the impression has been gained that British vessels are substantially below Continental destroyers in speed, a view which has been strengthened by the hitherto published trials of the standard types of British destroyers. In this connection it is of interest to place on record that the Thornycroft-built destroyer "Daring," the first of the "D" class to undergo her official trials, which were completed on Wednesday last in the Channel between Plymouth and Spithead, reached a speed of 38·2 knots. The "D" class destroyers of the 1930 programme have an overall length of 323ft. with a beam of 32½ft. and a depth of 12ft., and their trial displacement is about 1445 tons. The propelling machinery comprises a twin-screw arrangement of Parsons geared turbines, taking 300 lb. pressure steam with 200 deg. Fah. superheat from standard Admiralty pattern water-tube boilers. The prescribed speed is 36 knots, but on the trials last Wednesday the extra knots were easily attained. It is of further interest to recall that the speed is 10 knots more than that of the first "Daring" constructed by Thornycrofts nearly thirty-eight years ago, which made a record at the time.

The Engineering Industries.

IN the current issue of the *Bulletin* of the British Engineers' Association the financial results of the engineering and allied industries for March, 1931, to March, 1932, are analysed and reviewed. The statistics discussed are derived from the reports of "a representative sample of fully sixty engineering and allied companies," whose total paid-up capital amounts to almost £135 million. The aggregate amount of earned profits for the sixty-two companies involved shows a steep decline from £7·8 millions in 1929 to £5·4 millions in 1930, and only £2·6 millions in 1931, the ratio to paid-up capital in the respective years being approximately 6 per cent., 4 per cent., and 2 per cent. On the other hand, the total amounts of ordinary and preference dividends paid out diminished considerably, from £6·6 million in 1929 to £5·3 million in 1930 and £3·9 million in 1931, and the progressive decline, in proportion to paid-up capital, is approximately represented as 5 per cent., 4 per cent., and 3 per cent. Actually the exact ratio of dividends distributed to profits earned rose from 84·6 per cent. in 1929 to 97·9 per cent. in 1930 and in 1931 soared up to 149·4 per cent.; thus, once again, dividends far in excess of earnings were paid out to a considerable extent from the various reserve funds of concerns. This is seen in the fact that the net amount allotted to reserves, expressed as a proportion of paid-up capital, fell from 0·8 per cent. in 1929 to 0·4 per cent. in 1930, and now in 1931 actually figures as a debit, equivalent to 0·1 per cent. Moreover, the aggregate amount of undistributed profits, or "carry forward," has declined from 2·6 per cent. of paid-up capital in 1929 to 2·4 per cent. in 1930 and only 1·4 per cent. in 1931. The British Engineers' Association takes a gloomy view of the situation and anticipates, no doubt justly, that the analysis of the current year will be "still more calamitous." That year, we may recall, will end in March next and will include, therefore, the worst part of the slump and feel but little of the slow revival which appears to be taking place.

The New Naval Orders.

ON Wednesday, September 21st, the Secretary of the Admiralty announced the names of firms on the Clyde and Tyne which have been entrusted with the contracts for the destroyers and sloops for the 1931 programme, mention of which was made in our Journal note of September 2nd. On the Clyde, William Denny and Brothers, Ltd., of Dumbarton, and Scott's Shipbuilding and Engineering Company, Ltd., of Greenock, will build the hulls and machinery for two destroyers each; while the Fairfield Shipbuilding and Engineering Company, Ltd., of Govan, Glasgow, will construct the machinery for a flotilla leader, the hull of which is to be built at Portsmouth Dockyard. At Clydebank, John Brown and Co., Ltd., will construct the hulls and machinery for two sloops. The Tyne orders include two destroyers, which are to be built and engined by R. and W. Hawthorn, Leslie and Co., Ltd., of Hebburn-on-Tyne and St. Peter's Works, Newcastle-upon-Tyne; and two to be built by Swan, Hunter and Wigham Richardson, Ltd., Wallsend-on-Tyne, the machinery for which ships will be supplied by the Wallsend Slipway and Engineering Company, Ltd.

Coal Carbonisation at Glenboig.

IT is announced that the Scottish Gas Utilities Corporation, Ltd., of London, has completed an agreement to take over the Bussey low-temperature coal carbonisation plant at Glenboig, near Glasgow. Work is to be started immediately on the reconditioning of the plant and its extension to four times its present capacity. This work will possibly be completed at the end of October, but so far no date has been announced for the reopening of the works. The treatment of a maximum of 400 tons per day is contemplated, but initial operations will be begun with a smaller output. The Glenboig works, it may be recalled, were opened three years ago by the Bussey Coal Distillation Company, Ltd. In November, 1930, the works were closed down, and two months ago a statement was made that the plant at Glenboig had been purchased by the Financial and General Trust, Ltd., which would operate it on terms which would give the Bussey Company full advantage of all its experience and discoveries.

A Visit of Danish Engineers.

EARLY in the week a party of Danish municipal engineers arrived in London and will make a ten days' tour of inspection of various industrial establishments in England and Scotland. The visit has been arranged by the British Steelworks Association in co-operation with the Danish-British Association for Trade. This body, which has its seat in Copenhagen, has done much for the furtherance of trade relations between the two countries. Considerable interest in the visit is also being taken by the Development Council of the Department of Overseas Trade and by the various Danish municipalities whose engineers are taking part in it. The main object of the visit is to give Danish engineers an insight into British industrial methods and to acquaint them with the wide range and high quality of British steel and engineering products. The visit will also without doubt supplement in a valuable and personal way the British Exhibition which is to open to-morrow, Saturday, September 24th, at Copenhagen. The principal engineers who are making the tour, which includes visits to noteworthy public works, both in England and Scotland, are Messrs. Julius Hansen, the Chief Engineer of the Copenhagen Municipal Gasworks; A. T. Jorgensen, the Chief Municipal Engineer of Elsinore; Vilh. Marstrand, Consulting Engineer for Municipalities and the editor of *Ingenioren*; S. Stürup, the Chief Municipal Engineer of Frederikshavn; Poul Sorensen, the General Manager of the Copenhagen Waterworks and Chairman of the Association of Academical Engineers; V. A. Westergaard, the Chief Municipal Engineer, Gentofte, and the Chairman of the Association of Danish Municipal Engineers; and P. Friderichsen, of the Danish-British Association. The arrangements for the visit have been made by Mr. C. J. Kavanagh, Director of the British Steelworks Association, London.

Canadian Railways.

A STEP towards the uneconomic rivalry which for many years has been pursued by the two great railways of Canada has been taken by the Royal Commission under Mr. Justice Duff, which has been looking into the affairs of the "Canadian National" and the "C.P.R." A summary of the Commission's report was published this week. It recommends that mutual economies be enforced by a joint committee of the two systems without interference with the "physical integrity" of each system. The question of further extension of the present services is to be referred to the Chief Commissioner of the Federal Railway Board. To carry out these recommendations three Trustees of the National and an equal number of directors of the C.P.R. are to meet with the object of adopting as soon as possible co-operative measures. The Trustees referred to are to replace the present Board of Directors of the "National." If the joint Board is unable to reach an agreement, an arbitral tribunal composed of the head of the Railway Commission and one representative of each railway system is to be set up. The annual railway budget will be under the control of the Trustees, and all the necessary amounts required will be voted by Parliament annually, and not raised by the issue of railway securities, as has been the recent practice. The Commissioners conclude their report by stating that the plan outlined "will, they believe, ensure the progressive co-ordinated development of the railway systems on an economic basis, and afford early relief to the Federal Treasury by reducing the alarming increasing deficits, and that it will also effect a considerable measure of relief for the taxpayers of Canada."

Transmission Lines Across the Thames.

ON Sunday afternoon, September 18th, all shipping on the Thames was held up near Dagenham in order that the task of spanning the river with transmission lines might be begun. The ends of seven cables were connected to the tower on the Dagenham side and seven drums on which the cables were wound were placed on a barge, which was towed across the river to the Kent side. As the drums revolved the cables were allowed to sink to the bottom of the river, from which they are now being raised so as to form the overhead lines between the towers. As reported in the fourth annual report of the Central Electricity Board, the northern tower is located at Horseshoe Corner, near Dagenham, and the southern tower near the London County Council sewage outfall works. The towers are 487ft. high, giving a clearance between the lines and high water spring tide level of 250ft. The base width is approximately 120ft. Both towers are composed of riveted and painted rolled steel sections and the cross arms will carry six line conductors, in addition to the earth conductor at the top. The span between the towers is approximately 3060ft.

Salving the M2.

IF favourable tides and fine weather continue, it is hoped that an attempt will shortly be made to bring the sunken submarine "M 2" to the surface. During the summer months good progress has been made with diving operations conducted from the Admiralty vessel "Tedworth," which have been carried out day and night and are being continued. The work has included the fitting of a specially designed cover to close the foremost hatch and the sealing of the bow torpedo tubes, as well as the stopping of air leaks through loose rivets, &c. By means of oxy-hydrogen torches and pneumatic drills holes have been cut under water through both the outer and the inner hulls and arrangements made for the suitable discharge of water from the internal spaces when the air pressure is applied to the ship. Four pontoons are to be utilised to give the additional buoyancy required, two at the stern and two at the bow, and three of these have now been attached and work on the third is proceeding. Each of these pontoons will have a lifting capacity of 80 tons. When operations are finally completed air will be pumped into the submarine by five air compressors and the internal water forced out, when it is hoped that sufficient buoyancy will be given to bring the vessel to the surface. The salvage work, it may be recorded, is being carried out by the Admiralty under the supervision of Mr. E. F. Cox, of Cox and Danks, Ltd., of London.

The Galloway Water Power Scheme.

IN a Journal note of March 23rd last we recorded the commencement of construction of a tunnel for the Glenlee hydro-electric station, one of five to be built in the south-west of Scotland under the Galloway water power scheme, which, when completed, will have a total output of 14,000 S.H.P. Early in this week it was announced that a further contract for the construction of the power station at Tongland, three miles north of Kirkcudbright, had been placed with William Taylor and Son (Glasgow), Ltd. The value of the contract amounts to £80,000 and will entail two years' work on the construction of the reinforced foundations for the power-house, the surge tower, and a steel superstructure. The contract for the steel required in the building has yet to be placed. Work is already in hand for the concrete dam which spans the river Dee above Tongland Bridge. The equipment of the Tongland station will comprise three water turbines and generators, each of 11,000 kW capacity, which are being constructed by the English Electric Company, Ltd.

The Laboratories of La Société Hydrotechnique de France.*

By M. P. LEROUX.

No. I.

EXPERIMENTAL studies of river hydraulics are increasingly favoured, and the time is approaching when no work of importance will be undertaken without preliminary attempts to determine experimentally, with a model on a reduced scale, the principal characteristics of its working; whether it be desired to verify *a priori* calculations, or whether, and this is the more frequent case, the purpose is to obtain information on points to which calculation does not apply.

Abroad, notably in Germany, a number of laboratories have been equipped to fulfil those requirements. In France, one may cite, amongst others, the very interesting experiments carried out at Toulouse on small-scale models, by Monsieur Carmichel, and the work of the Société Hydrotechnique de France, some details of which are given hereinafter—to mention only existing establishments and without reference to those, the construction of which is projected.

The Société Hydrotechnique de France has organised studies of river hydraulics in its laboratory of Saulcy, at Metz (specially created for that purpose), and at that of Beauvert at Grenoble.

In communications to the Mechanics Section, to which reference may be made, the writer and his colleague, Jean Laurent, dealt, in one part with the Hydrotechnical Society, and the services which it performs, and, in the other part, with the laboratory of Beauvert and its equipment. The present paper relates to the laboratory of Saulcy and to some examples of work carried out at Beauvert, and explains the ideas on which collaboration between the two laboratories is based.

I.—THE LABORATORY OF SAULCY.

Origin.—The origin of the laboratory of river hydraulics established at Metz, on the island of Saulcy, by the Société Hydrotechnique de France, may be referred to the year 1924, at the end of which Monsieur de la Brosse, Inspector-General of Ponts et Chaussées, presented a report containing a programme of studies to be undertaken in order to determine the law of distribution of velocities in open canals of complex cross section. The subject was brought up when studies were being made of the Grand Canal of Alsace, in order to discover whether it would be advantageous to provide a cross section of that type, such as the double trapezoidal form, in which the deep and swiftly running portion would carry the flow required for large-scale power production, while the shallower and slower running portion would serve for navigation.

In view of the difficulty of foreseeing *a priori* how the general average velocity would be divided between the two parts of a given cross section, Monsieur de la Brosse proposed to make a general study with a canal of smaller dimensions, in which there would be provided the various dispositions which might be expected to give the complex cross section aimed at.

After a study of various projects for the establishment of such a canal, the Direction des Forces Hydrauliques decided, in 1928, to modify for the purpose a canal of the old National gunpowder factory of Saulcy, at Metz, Monsieur Vidal, Inspecteur général des Ponts et Chaussées and President of a Committee charged by the Minister of Public Works with the examination of the various projects submitted, having proposed that this solution should be adopted.

Since the island of Saulcy forms a part of the territory of the Ministry of War and is also a part of the town of Metz, it was necessary to treat successively with the local military authority and with the municipal administration before commencing to carry out the works adopted for the experiments, the agreements being facilitated by the friendly attitude of those administrations towards the Société Hydrotechnique de France, which was charged with the execution of the works and the carrying out of the contemplated experiments.

The establishment and control of the new laboratory were entrusted to Monsieur Hégly, a retired chief engineer of the Ponts et Chaussées, whose name alone—well known to hydraulic engineers who appreciate his important researches, notably those on canal and weir discharges—is a guarantee of the scientific and practical value of the work undertaken on the island of Saulcy. It is by courtesy of Monsieur Hégly that the writer is able to furnish the present information relating to that laboratory.

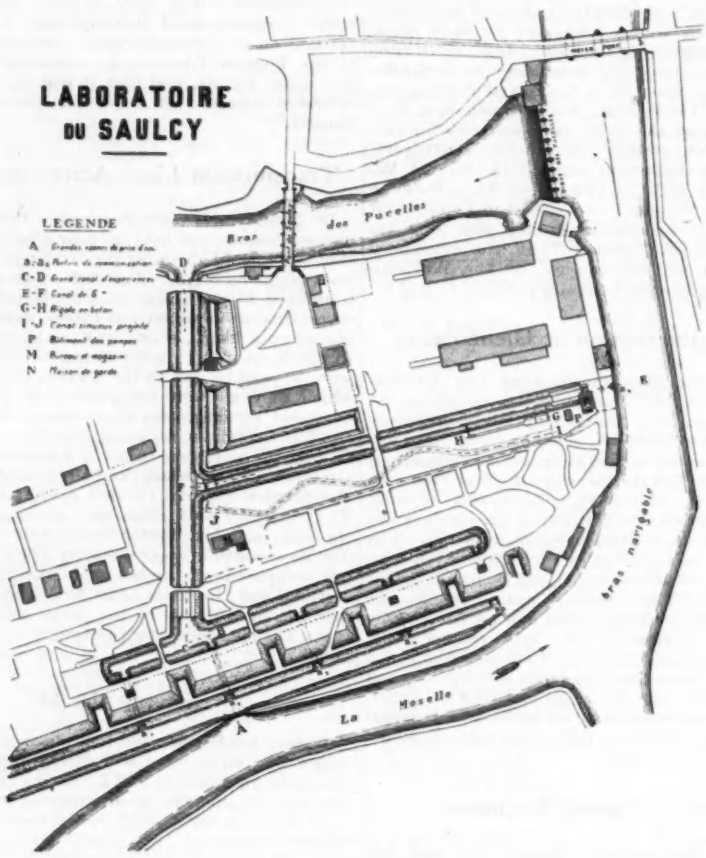


FIG. 1—*Plan of the Saulcy Laboratory. A, Large Intake Sluices. a_1–a_4, Communication Sluices. C–D, Large Experimental Canal. E–F, the Six-Metre Canal. G–H, the Concrete Channel. I–J, the Projected Winding Canal. P, Pump House. M, Office and Store. N, Caretaker's House.*

DESCRIPTION OF THE INSTALLATIONS.

The installations of the laboratory of Saulcy—see Fig. 1—comprise, at the present time:

(1) A model on the scale 1/20 of the canal of complex cross section, as conceived by Monsieur de la Brosse, in connection with studies of the Grand Canal of Alsace.

(2) A model of the same canal on the scale 1/50.

(3) A concrete channel designed for the study of the discharge of solid materials.

(4) A pumping station for the supply of water to the last-named work and to the winding canal hereinafter referred to.

(5) In addition to these elements, some of which are nearing completion, there will shortly be constructed a winding canal, in earth, already projected, and intended for the study of flow through bends.

Let us examine successively, these various parts of the laboratory.

1.—THE CANAL OF COMPLEX CROSS SECTION, ON THE SCALE 1/20.

In the construction of this canal, which, as already noted, is the very origin of the laboratory, the main, or fosse, ditch, was utilised, this ditch dividing the grounds of the old gunpowder factory into two equal parts and serving as an outlet to the Moselle for the other ditches provided for the various purposes of that establishment. The work comprises the following elements.

Intake and Receiving Pool.—The water required for the experiments is taken directly from the navigable branch of the Moselle through a wooden sluice. This intake sluice discharges into a moat 9·5 m. (31·17ft.) wide, formed on the island to a length of 8·1 m. [query misprint for 81 m. (266ft.)] and plays the part of a regulator of the upstream level.

The moat communicates, by means of masonry sluices closed by wooden shutters, with a receiving pool 7·5 m. (24·6ft.) wide, and about 250 m. (820ft.) in length, in direct communication with the work upstream of it, its capacity adding to the regulating effect of that of the moat. As successor in title to the military authority previously owning the land on which it is established, the laboratory may at all times dispose of a flow of 1·2 mecusecs (42·4 cusecs) and, with mean discharge in the Moselle, of a flow of 2·0 mecusecs (70·6 cusecs).

The Upstream Work.—Before being used in the experiments, the flow borrowed from the Moselle passes through an upstream work in which the gauging is carried out; a canal of rectangular section 18 m. (59ft.) long, 5 m. (16·4ft.) wide, and 1·5 m. (4·92ft.) deep, the cement concrete walls of which are rendered to a smooth surface. At the downstream end there is a timber weir, the two openings of which, separated by a metal pier, or post, and provided with sill plates, form the gauging weir—Fig. 3. The crest of the weir is 1·0 m. (3·28ft.) above the floor of the canal, retaining that depth of water in the receiving basin, thus constituted as a flow regulator, a water "fly wheel," as it were, by means of which variations in the flow taken from the Moselle and due to fortuitous changes in the water level of the navigable branch, are represented only by feeble oscillations on the surface of the stored water. The conditions are, therefore, favourable to easy regulation of the discharge provided for experiment, such as is not available in other laboratories.

The two metal sill plates of the weir deliver a nappe free from side contraction. They originated in the Moulin-Rouge experiments carried out by Monsieur Hégly at Langres in 1915–16, in the course of which studies were made of all forms of overflow weirs, symmetrical or not, which can be constructed.

For measurement of the head over the sills a gauge well has been provided behind one of the side walls. It communicates with the canal by a hole 1 cm. (0·39in.) in diameter, with ends flush with the wall faces. In horizontal section the well is a rectangle 65 cm. (25·6in.) by 45 cm. (17·7in.), sufficient to accommodate the float of an apparatus for recording the heads over the weir sills, also a hook gauge for taking readings of the water levels. Measurements of the heads over the weir sills are also made by means of cast metal datum plates on the coping of the gauge well and above the ends of the weir. Their levels are carefully checked several times in the course of the year. Measurements are made of the depth, below the plane of these datum plates, on the one hand, of the level of the weir sills, and, on the other hand, by means of the hook gauge, of the water surface in the gauging channel. The difference gives the head in the calculation of the discharge.

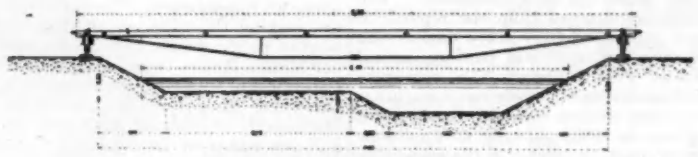


FIG. 2—*The Bi-trapezoidal Canal.*

The Experimental Canal Proper.—The part of the main ditch which is used for the experiments (Fig. 4) has a length of 184 m. (603·7ft.) measured between the downstream end of the gauging channel, upstream of it, and the upstream end of the work downstream of it, to be described hereinafter. The width is 7·6 m. (24·94ft.) between tops of side slopes. In its

* Translation in full of a paper presented at the Congrès de Génie Civil, held in Paris, September 23rd to 29th, 1931, and published in the July-August, 1931, *Bulletin* of the Société des Ingénieurs Civils de France. The Editor desires to thank Monsieur Leroux for the loan of the original blocks.

first and present form it is bi-trapezoidal, corresponding to the cross section proposed by Monsieur de la Brosse, reduced to the scale 1/20. The bottom widths are, in the deep portion, 1·65 m. (5·41ft.), in the shallow portion 2·75 m. (9·02ft.), the respective depths being 0·5 m. (1·64ft.) and 0·2 m. (0·66ft.). The side slopes and the underwater slope are 1 in 2. The bed fall is 0·000082 (0·082 per 1000, or 1 in 12,195), given by the difference in altitude 14 mm. between the concrete floors constructed at the upstream and downstream ends of the canal.

It is obviously possible to make in this cross section any modifications rendered necessary in the course of the experiments, as well as such as may relate to any other research.

Along each bank there is laid a rail, on longitudinal sleepers, these serving as the railway for a travelling footbridge which carries the various apparatus used in the experiments—see Fig. 2.

Along the left bank of the canal are ranged reference, or datum, stakes, the altitude of which has been carefully determined, these providing for the determination, at any time and in a general taking of levels, of the altitude of the water surface alongside each stake.

The Downstream Work.—The work at the downstream end of the experimental canal is similar to the work upstream, but it is shorter, wider, and of less height, these dimensions being respectively 9·30 m., 7·50 m., and 0·80 m. (30·5ft., 24·6ft., and 2·62ft.). It can also be used for gauging the flow, or at least as a check of the measurements made at the weirs upstream, for it has three small metal piers or posts, dividing it into four openings which are closed by oaken stop planks, on which discharge measuring sills could easily be fixed. The main purpose of this stop plank weir is to hold up the water in the experimetal canal so as to establish in it the *régime* of flow which is the subject of an experiment, a *régime* either uniform or uniformly changing.

In this case two gauge wells have been provided, one at each side of the work, at 5 m. (16·4ft.) upstream of the weir. Their communications with the corresponding portion of the canal are, as in the work upstream, in each a small hole 1 cm. (0·39in.) in diameter. Peculiar to this downstream work is a concrete guide wall along its axis, 9·95 m. (32·65ft.) long and 12 cm. (4·74in.) thick, dividing the work into two equal parts (Fig. 5). The purpose of this arrangement, constructed after the experiments had been begun, is to provide alternative dispositions of the flow at the downstream end of the canal, according as it may be desired; to pass the whole discharge through the two openings which correspond to the deep portion, or through the two left bank openings which correspond to the shallow portion; or to divide it between the several openings of the weir.

(2) THE CANAL OF COMPLEX CROSS SECTION ON THE SCALE 1/50.

The experiments carried out on the canal of 1/20 scale, the results of which will be given hereinafter, showed it to be necessary to undertake a fresh series of researches on a canal of greater length on which will be more clearly evident certain phenomena of which the canal first installed has only allowed glimpses to be seen. It seems, moreover, that it will be desirable to make the new model on the scale of 1/50, which will furnish two reductions, by means of which the law of similarity may more effectively be applied to flow in open canals.

The new canal, now in course of construction, is called the 6 metres canal, this being the width between the feet of the slopes which are its limits. Like the first canal, it is constructed in earth, the width between tops of side slopes being 3·04 m. (9·97ft.), whereas in the larger canal, as already noted, that width is 7·6 m. (24·93ft.). With normal water levels the water surface widths are respectively 2·56 m. and 6·40 m. (8·4ft. and 21·0ft.), corresponding, on the scales of 1/50 and 1/20 to a full-size width of 128 m. (420ft.) for a dual purpose navigation and power canal. The water depths, varied during the course of the experiments, will range round about 8 cm. (3·15in.) in the shallow portion and 20 cm. (7·87in.) in the deep part, corresponding to natural depths of 4 m. (13·12ft.) and 10 m. (32·81ft.) in the full-size canal.

The two works at the upstream and the downstream ends have been constructed and are in service. They are 215 m. (705·4ft.) apart, the length of the experimental canal proper. Supplied with water directly from the Moselle by means of an arched sluiceway, the upstream work, which is 4·0 m. (13·12ft.) in width, is closed at its downstream end by a weir. The walls are vertical, a gauge well 5 m. (16·4ft.) upstream of the weir being incorporated with that on the left.

The downstream work is 7 m. (22·97ft.) long, 4·0 m. (13·12ft.) wide, and 0·32 m. (1·05ft.) in height. It is provided with two gauge wells, permitting of observations of levels being taken on both banks. Divided into four openings closed by stop planks, it serves as a regulator of water levels in all parts of the canal. The complete closing and staunching of the openings will transform the whole of the canal into a basin of capacity sufficient to provide for the volumetric rating or calibration of the openings of the upstream weir. It will, indeed, be easy, when the experiments on the bi-trapezoidal cross section are concluded, to construct, in the whole length of the canal, a masonry channel 3 m. (9·84ft.) wide and at least 1·2 m. (3·94ft.) in depth, which will permit of

FIG. 3—*The Canal of Complex Cross Section: the Upstream Work Viewed from Downstream.*

FIG. 4—*The Canal of Complex Cross Section on the Scale 1/20.*

FIG. 5—*The Canal of Complex Cross Section: the Downstream Work Viewed from Upstream.*

FIG. 6—*The Concrete Channel for the Study of the Discharge of Solid Materials: the Complete Work Viewed from Downstream*

FIG. 7—*The Receiving Basin Showing the Regulating Notches.*

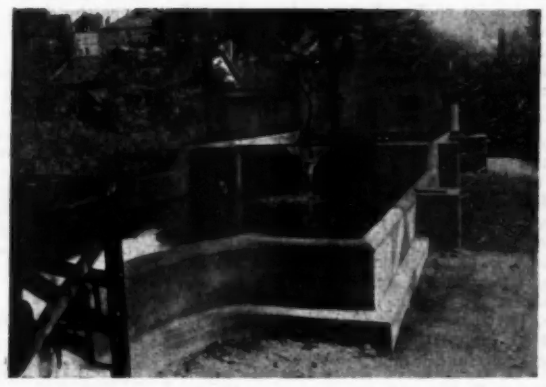


FIG. 8—*The Concrete Channel: the Downstream Basin, Showing the Right-angle Notch and, as in the First Disposition, the Left Bank Elliptical Joining Wall.*

other studies being made of flow in open canals on a sufficiently large scale, as well as of volumetric rating; for the available volume in the basin so furnished will then be about 600 cubic metres (21,190 cubic feet).

(3) The Concrete Channel for the Study of the Discharge of Solid Materials.

This channel (Fig. 6) is of rectangular section, 1·2 m. (3·94ft.) wide and 90 cm. (2·95ft.) deep. The vertical walls and the floor, or invert, are of cement concrete, rendered with mortar so as to be perfectly water-tight.

In its length of 49·3 m. (161·74ft.) it is in two parts:—

(*a*) The upstream portion, 13·8 m. (45·28ft.) in length is in two sections, one of which, 7·4 m. (24·28ft.) in length, serves as a receiving basin for the water delivered by two pumps which are supplied from the work upstream of the 6-metre canal, already described. The other section, 6·4 m. (21·0ft.) in length is an intermediate basin preceding the channel proper. The whole portion (*a*) is uniformly 4·0 m. (13·12ft.) wide, with walls 1·25 m. (4·1ft.) and 0·9 m. (2·97ft.) in height.

(*b*) The downstream portion, 35·5 m. (116·47ft.) in length, constituting the channel proper, commences with a junction by vertical walls, in plan elliptic arcs, with the basin at its upstream end.

Upstream of the channel, a little beyond these elliptic joining walls, a timber frame, resting upon the basin walls, provides for the strewing of the sand which constitutes the solid content in the discharge. Within the channel itself, at 3·5 m. (11·48ft.) from the upstream end, there is a recess or trench formed in the floor during construction, 70 cm. (27·56in.) deep, provided with a cover in the form of a movable metal plate (or trap door), which permits or interrupts the continuity of flow of the sand-laden water. Two metal vessels, 1·05 m. by 0·60 m. by 0·50 m. (3·44ft. by 1·97ft. by 1·64ft.) in dimensions, lie in this recess during the experiments. The plate having been removed (or the cover having been raised), these vessels are lifted out by means of a travelling bridge and a tackle, for the weighing of the sand which has collected in them.

In order to control the flow in each experiment, the delivery basin of the pumps is provided with two small symmetrical notches—Fig. 7. The crest of each is formed by two hinged boards, to which are attached two metal cheeks which are raised or lowered to the height required to give exactly the experimental flow. This flow is measured by a right-angle notch (Fig. 8), rated as a Thompson notch, by means of which a depth of overflow great enough to render of relatively small importance errors in the readings of discharges, may be maintained with a small flow.

There are five gauge wells, formed behind the left wall of the channel, providing for precise observations of the levels of water, and giving therefore the longitudinal profile of the flowing water; also for measurement of heads over the sills of the weirs which regulate the discharge. Angle irons, fixed to the tops of the channel walls, provide a perfectly horizontal railway on which runs a carriage containing the measuring rods and other apparatus for taking measurements.

Finally, there is, at each end of the channel, a fall or drop formed on the left bank slope of the 6-m. canal. At the foot of each fall there is a masonry outlet, communicating with a conduit which forms a drain under the canal.

(4) The Pumping Station.

The pumping station to which reference has been made is for the supply of water to the winding canal on the scale 1/50, and to the channel for the measurement of the discharge of solid materials. It is equipped with two Rateau centrifugal pumps, the current for which is taken from the town supply at 190 volts, the duties of the two pumps being respectively 50 and 100 litres per second (1·77 and 3·53 cusecs or 660 and 1320 gallons per minute). The suction pipes are separate, the delivery pipes interconnected for discharges of 50, 100, or 150 litres per second. These pumps are in a special building.

(5) The Canal in Earth for the Study of Bends.

It has been realised that in order to complete the study of the complex cross section it would be necessary to make experiments, in a canal of such a form, on the effect of bends upon the distribution of velocities throughout the cross section. But this can only be done by giving to the experimental canal a winding alignment which follows bends of suitably determined radius. The two straight canals on the scales 1/20 and 1/50 are located in ditches of some depth which is an obstacle to modification of their alignments. The new canal, which is still at the project stage, will therefore be formed at ground level on the Island of Saulcy, above the existing canals. It will be on the scale 1/50, and will have two series of bends of radii representing 250 m. and 500 m. (820ft. and 1640ft.) on the natural or full-size scale. With each such radius there will be a bend to the right and one to the left in relation to the general direction of the canal. The water will be supplied by the pumping station just described.

The First Experiments Carried Out at Saulcy.

Although its construction is quite recent, and even incomplete, the Laboratory at Saulcy has already carried out very interesting works which call for notice. They relate to studies on the canal of scale 1/20 of bi-trapezoidal cross section. Researches relating to the weirs and to the flow of solid materials (in suspension) are, moreover, now proceeding.

The Study of the Bi-trapezoidal Canal.

Experiments were successively made with the canal in gravelly soil; with perimeters of clay well punned to make it very compact; and finally, with a covering on the bottom of the shallow portion and the adjacent left bank side slope of Moselle pebbles, 5 cm. (2in.) in thickness, and in their other dimensions from 8 cm. to 10 cm. (3in. to 4in.).

Velocities were measured with the Pitot tube at different points in the sections studied; surface velocities by means of weighted or ballasted floats.

Various *régimes*, uniform and uniformly changing, were studied.

Of the fifteen experiments made, eight, group A, were with rough perimeters; three, group B, with smooth perimeters; four, group C, with the pebble covering on the bottom of the shallow portion and the left bank slope.

The detailed results of these experiments and the interesting deductions which can be made from them cannot here be given, and the present account is limited to a brief summary. (For further details, see "Note on the Distribution of Velocities in a Canal of Complex Cross Section," by V.-M. Hégly, Comptes Rendus de travaux de la Société Hydrotechnique de France, *Revue Générale de l'Electricité*, November 1st, 1930, pages 519 H *et seq.*).

From the Pitot tube velocity measurements, curves of equal velocity were drawn for every cross section studied, and the mean velocity in each of the parts of the section deduced therefrom. Comparisons between these velocities furnishing most interesting results.

In the group A and group B experiments, for which the velocities in the two parts were comparable, the nature of the perimeter being the same in the deep and in the shallow portions, the relation between the two velocities ranged from 0·355 to 0·763. It increases as the depth in the cross section increases, the lower figure given corresponding to 10·6 cm. (4·17in.) in the shallow portion and 47·2 cm. (18·58in.) in the deep portion. This minimum of 0·355, which is exceptional, shows that a slight reduction of the depth in the shallow portion has an immediate effect in reducing the average velocity in that part. It is also to be observed that the three experiments in series B give proportions which, for a depth of 20 cm. (7·87in.) in the shallow part, are notably higher than in series A. It is therefore probable that by making the wetted surfaces smoother, there is produced the same effect as that due to an increase in the depth of the water.

In the four experiments in group C the same proportion ranges from 0·469 to 0·550 for depths ranging from 17·6 cm. (6·93in.) to 24·7 cm. (9·72in.) in the shallow part. The variation is therefore less pronounced than in group A, but, as was to be expected, the proportion is on the whole less.

To sum up the results, it seems that the flows in the two parts of the bi-trapezoidal cross section studied behave as though independent, as it were, at least so long as the depth of water in the shallow part is not appreciably more than 2 cm. (0·787in.) less than that in the deep part. The independence of the two parts is evidently not complete. There is no well-marked line of separation between them, fixed in time and in space. On the contrary, the two parts act upon each other to establish a certain equilibrium in the movement, by means of oblique currents which the float observations have revealed; but this zone of agitation is so narrow that there are established two very clearly distinguishable parallel currents, each of which substantially occupies the corresponding part of the cross section.

(To be continued.)

The British Association.

No. IV. (*conclusion*).*

A New System of Lighting at the Coal Face.

Professor W. Cramp, in a paper before Section G (Engineering) on Tuesday, September 6th, described a new system of lighting at the coal face. The light at the coal face, he said, should be greatly increased. The candle-power of safety lamps was less than one-tenth of what was desired; electric portables had been immensely improved, but the battery was becoming of such a size as not to be portable. The required illumination was about 0·4 foot-candles, but the safety lamps did not give more than about 0·04. If the miner had better light, not only would the conditions of his work be far more congenial, but his output and earnings would be greater, and many accidents would be avoided.

The problem to be solved was the provision of safe and effective lamps fed from the mains at the coal face. Usually the face was so far in-bye as to render a supply of low pressure impracticable, so that the lighting fittings generally must be made suitable for the same voltage as the coal cutters, unless a special lighting transformer were installed. Moreover, the only type of lamp available was the incandescent bulb, which could not be made suitable for a pressure exceeding 250 volts, and which required reasonably constant voltage at its terminals. The result was that, whether the pit be of the "naked lamp" or of the "fiery" variety, in principle only three systems of mains lighting had been proposed hitherto. These alternatives were:—(1) To put two or more lamps in series between power phase wires; (2) to put lamps (*a*) in series or (*b*) in parallel between phase wire and neutral; (3) to feed the lamps through a special lighting transformer supplied from the power mains.

In the new system described by Professor Cramp it is proposed to make use of the principle of lighting by local induction, *i.e.*, to have no electrical connection whatever between the lamps and the supply mains. Instead, each lamp is connected permanently to the secondary of a small transformer, whose primary is fed from the mains. When the lamp is to be used, and only then, its secondary is rendered active by being placed close to its primary coil, so that it is magnetically coupled thereto. When the lamp is to be extinguished, it is simply removed from the neighbourhood of its primary. No switch is needed, and no circuit is broken.

At first it was hoped that it might be possible, by providing primary circuit supplied at, say, 1000 periods per second, to avoid the use of an iron core in the transformer; but experience had shown, not only that such an arrangement would be costly in copper, but that it might cause undesirable currents to flow in neighbouring conducting material. Having decided to adopt an iron core, it was essential to devise an arrangement under which, when a lamp and its secondary were removed, practically no change should take place in the primary circuit; otherwise, each primary must be switched out before removing its secondary, and the system would be no better than its predecessors. Gradually, it had become evident that if a single circuit could be arranged with a transformer primary for each lamp, all the primaries being in series, the result would be almost ideal, since the pressure across each primary could be kept quite low. Then, when the secondaries were placed in position, the system would operate at any appropriate constant supply voltage, and yet would under all circumstances take practically the same current.

To obtain these results, it was necessary that the lamp load should merely change the phase of the constant primary current; and this in turn meant that when no lamps were in operation the transformers must be so designed as to take a magnetising current equal to the current on load. The three conditions to be satisfied were that the primary current must have its stipulated value when the secondary was removed; it must have the same value when the lamp was in position and alight; it must not change substantially, even if a lamp broke or became short-circuited.

The characteristics of the system are summarised as follows:—(*a*) There is one twin armoured primary lead which runs throughout the lighting circuit, connecting all primaries in series. (*b*) The voltage across each primary is the main supply volts, divided by the number of primaries per circuit, *e.g.*, with 21 per circuit, and applied volts 440, the pressure on each primary coil is only 21 volts. (*c*) Every primary is totally enclosed, isolated from the lamps and sealed in. (*d*) There are no switches except one in the primary at the supply end. Any lamp can be safely removed or extinguished without opening a switch. (*e*) The pressure on each lamp can be as low as is necessary to prevent danger. In the demonstration system it is 25 volts. (*f*) All secondaries can be earthed at one terminal, if desired, but this course does not seem to be either necessary or desirable. (*g*) The removal of a live lamp automatically extinguishes it without interfering with the others of the same circuit. (*h*) The accidental burning-out or short-circuiting of a lamp does not interefere with others on the circuit, nor cause any damage.

Elasticity and Hysteresis of Rocks and Artificial Stone.

Another paper presented to Section G on Tuesday, September 6th, was one by Mr. J. Gilchrist and Dr. R. H. Evans, in which was described a new method of investigating the elastic properties of rocks, part of which consists in allowing a column of the material to stand for a long time under a given load, and then to vary this through a small range. The strain so obtained is termed the short-range strain, from which the short-range modulus can be calculated. In general, for stone and concrete the short-range strain decreases with increasing load, and the modulus increases. This short-range strain, with certain limitations for concrete, is a constant magnitude found always on returning to the same average load; it is independent of time. The sum of the short-range strains integrated between two given loads differs from the actual strain obtained when observations are made in the ordinary manner. The difference between this integral short-range strain and the actual strain is a time effect. The authors suggest that this conception of a short-range strain combined with the time effect gives clearer ideas of the stress-strain relations of the materials in question. For example, the elastic

* No. III. appeared September 16th.

hysteresis loop can be explained in terms of these two effects.

Cracking and Fracture in Rotary Bending Tests.

The first paper read at the final session of Section G, on Wednesday, September 7th, was by Professor F. Bacon, who described some experiments, the primary aim of which was to reproduce in laboratory tests the features found on the fractured faces of rolls, shafts, and axles which have failed in service by the gradual spreading of cracks. All the experiments were carried out in the engineering laboratories of the University College of Swansea, with a view to adding to our present rather meagre stock of organised knowledge concerning cracking and fracture in shafts, axles, and rolls in so far as these are due to the action of rotary bending. The investigation arose from a desire to interpret the various markings of simple geometric form often found on the freshly fractured faces of the chilled iron rolls used in the hot mills of sheet and tin-plate works.

Two fatigue testing machines were used, having been specially developed to study the various stages of the crack-spreading process, the modifications caused by the contact pressure of loaded rollers, and the influence of periodically varying the limits of successive cycles of alternating stress. In order to obtain conditions of stress not too far removed from those to which rolls are subjected, a fatigue testing machine of the revolving beam type was adopted, and a cyclic overloading device added, to make a start at filling the gap in our knowledge between fatigue testing at constant load and service conditions under varying load. Apparently almost all previously published results on fatigue testing, says the author, have been carried out at constant load, yet a variable load or a load with peaks at intervals is far more often what the designer of the rolls has to provide for. There is one aspect, however, in which rolls differ from the ordinary run of design problems. It is an open question whether it is absolutely necessary for finishing rolls to have an indefinitely long fatigue life, in view of the fact that the chilled working surface is inevitably worn and turned away in three or four months. This may mean that finishing hot mill rolls can be permitted to have a limited fatigue life without shortening their useful life.

The amount of data collected under cyclic overloading is as yet insufficient to merit publication, but the indications are that the damaging effect is greater than would be predicted on the assumption that all the turns made at stresses below the fatigue limit could be ignored. Experimenting with lower limits down to 65 per cent. of the fatigue limit and upper limits reaching 10 per cent. above the fatigue limit, no test has yet shown a life exceeding four times that corresponding to continuous running at the upper limit.

The rotary bending machine used can apply uniform bending moments up to at least 1000 in.-lb. over gauge lengths of 1in. to 1ft. at any selected speed from 350 r.p.m. to 3500 r.p.m.

To understand the significance of fractures the whole of the crack-spreading process must be studied, for it is during that process that the features of the fractures receive their final imprint. Hence, it has been the author's aim to catch and examine fatigue cracks in all stages of macroscopic development. Four methods have been found of service: (1) coat the specimen with an adhesive but brittle layer of quick-drying paint. Allow time for the paint to dry hard. Then run the fatigue machine under load for a few minutes. If the crack works through the paint layer it is easily seen. This, in the author's experience, is preferable to the well-known paraffin and whiting method. (2) Magnetise the specimen and sprinkle it with fine particles of reduced iron. (3) Polish, etch, and re-polish as often as may be deemed necessary. (4) Test for rise in electrical resistance over a short gauge length embracing the region where the crack (if any) is likely to occur. For the purposes of the research, etching and re-polishing was the procedure generally chosen as being the most convincing and informative.

Of destructive methods of crack detection, pulling is clearly preferable to bending, as it tends to open up cracks equally all round the specimen instead of only on the side which is stretched by bending.

The material used in the preliminary studies to which the paper relates was a commercial medium-carbon steel conformable to Specification No. S70 of the Air Ministry.

Some of the constantly recurring features of service breakages which have been reproduced successfully in the laboratory tests are shown to be related to the direction of rotation.

A set of endurance curves for specimens of different forms on a basis of 10,000,000 cycles is shown and discussed in the paper. A peculiarity of some specimens was the remarkable extent to which they could be strengthened by "understressing." In one case the stress was raised five times before the specimen broke, and it is not certain that it would have failed then if the stress increment had not been increased to a degree which caused the specimen to run hot. The specimens completed about 10,000,000 cycles at each particular stress intensity before the stress was raised to the next level. It is suggested that this exaggerated effect of understressing is rendered possible by the fact that this particular form of specimen is long and slender and that the testing speed (about 3000 r.p.m.) was well above its first critical speed. The resulting dynamic stability helped the specimen to strain-harden by checking the tendency to deform when its elasticity was temporarily broken down.

Experiments on some of the other specimens led to the suggestion that a streak of non-metallic inclusion outcropping at a sharp corner would act as a powerful "stress-raiser." The fracture study of some specimens revealed that they failed prematurely because there were grinding grooves at the base of the fillet, and the author emphasises that tool marks are more damaging at the base of a fillet or the bottom of a groove than anywhere else. Yet, by the irony of fate, these are the very places where the turner or grinder finds the greatest difficulty in avoiding them.

As to classifying fractures obtained in rotary bending tests, the author suggests that a start could be made by distinguishing between "simple" and "compound" fractures, the former being those in which the whole of the cracked area has presumably spread from a single origin, and the latter those in which separate cracks have spread from independent origins. To encourage the production of simple fractures, the author has sometimes used a surface wound to act as crack origin, using for this purpose two diamond indenting tools, accurately located, and forced in under measured load. Artificial crack origins are not really necessary, however, to secure simple fatigue fractures. In ground specimens some grinding scratch deeper than its neighbours starts the crack, and if the specimen is polished, some non-metallic inclusion is generally at hand to serve the same purpose. The art of obtaining good specimens of simple geometrical fatigue fractures is really that of interrupting the fatigue test at the right moment. The cracked specimen is then removed from the fatigue tester and broken statically—preferably in tension. If the fatigue machine is stopped too soon, only an ordinary tensile fracture is obtained, and if only a few revolutions too late, the crack will have spread too far. In the steel used (which displayed a high degree of notch brittleness) a load sufficient to produce a fatigue crack of macroscopic proportions causes it to spread at a great pace. On the other hand, if the load is reduced as soon as the crack appears, the cracked specimen may run on for millions of cycles without suffering detectable change. A fatigue-cracked specimen has its own fatigue limit just as much as an artificially notched specimen, and the marvel is that it can be a fairly high one in spite of its narrowness and depth.

Among the methods of crack detection discussed in the paper is a method of fatigue heat-tinting, for the purpose of mapping out the crack-spreading process. By piecing together a number of simple one-sided fatigue fractures with due regard to angular displacement in relation to direction of rotation, some of which were fatigue heat-tinted, the author has been able to map out a crack progress chart. It shows clearly how successive crack boundaries move radially inwards in an arc of increasing radius which becomes a straight line a little short of the centre. It also shows that as the crack front advances it also slews round a little in the opposite direction to which the specimen rotates in the fatigue machine. That represented "crack slip," the explanation of which is that the crack causes the specimen to sag plastically, but this plastic sag immediately calls out reactions from the guides of the floating bearings towards which the deflected centre of the bent specimen is swung by the rotation. These reactions set up a couple in the horizontal plane, which in the process of straightening the specimen exerts a tearing force on the trailing tip of the crack. The leading edge of the crack never experiences an equivalent tearing action because half a turn later the crack is under compression, in which position the already straightened specimen is too stiff to bend.

Mr. R. A. MacGregor (Darlington Forge Company) illustrated a number of examples of fatigue fractures of various materials which had occurred in service in order to demonstrate the similarity between them and the artificially produced fractures shown by Professor Bacon. From them one could read the causes, largely by instinct. Professor Bacon's work, he said, would be of great help in the diagnosis of such fractures. One of the fractures illustrated was of particular interest as showing the consequences arising from the building up of the horn of a marine engine crosshead which had worn in service. During sixteen years' service the diameter of the horn had been reduced from 6½in. to 6in., and the engineer responsible had rough machined it and had built it up to its original diameter by welding. Six years later the horn had broken in service, and it was found that a fatigue crack had developed almost completely through the diameter of the horn. Mr. Macgregor suggested that when the surface had been rough machined in order to ensure that the welded material would adhere to it, tool marks had been left amounting to a leading crack, and from that the crack had developed practically right through in six years.

Professor F. C. Lea, discussing the effect of discontinuities on the problem of fatigue cracking, said he did not think we should get very far by investigating cracks after they had occurred. The problems which were of fundamental importance were when the crack would start, what circumstances were likely to lead to a crack starting, and whether it started at the crystal boundary or within the crystal itself. A crack might commence at the keyway of a propeller shaft, for instance, *i.e.*, at a discontinuity; a small crack at a discontinuity would sometimes lead to extraordinarily early failure. In some experiments a steel specimen was covered with a deposit of nickel, with a certain initial stress, and a certain solution was used so that when the nickel cracked the solution would get through it and come into contact with the steel, so that a blue line was produced, indicating when the crack had started. Such specimens failed more quickly, and the fatigue range was lower, than was the case if the intial stress were lower. Material in the black condition had a fatigue range very much smaller than material in the turned and polished condition. If a wire were drawn through the dies until it had a tensile strength of 100 tons per square inch, and if it had to bear in service a load of 10 tons per square inch, it was perilous to represent that it had a factor of safety of 10. In cold-worked material, although under the microscope one could not find any surface discontinuity in the form of a hair crack, and in very many cases one could not discover it by means of iron filings or magnetic test, yet there was some particular surface condition produced—which he visualised as a condition of the crystal boundary—leading to the commencement of a crack. No wires that he had found, having a tensile strength of 100 tons per square inch, had a fatigue range greater than a small fraction of that tensile strength. In a ground steel having a tensile of about 100 tons per square inch one could probably guarantee 70 or 80 tons fatigue range; if the surface were black, the fatigue range would be a small fraction of the tensile strength.

Dr. G. Stoney expressed the hope that Professor Bacon would continue his work, for the investigation of the effects of varying loads would lead to results of very great interest. He recalled a curious instance which occurred some years ago, showing how small grooves, cut for the labyrinth packings in a turbine shaft, had weakened the shaft. The diameter of the shaft was 10in. and the grooves were ⅛in. deep, and a crack had developed downwards from the bottom corner of the first groove. The difficulty was overcome by the proper shaping of the fillet, and he urged all engineers to insist upon close inspection to ensure that fillets were properly shaped.

Sir Henry Fowler said that in nearly all cases fractures arose from fatigue, and that fatigue arose from matters of design or because of the material. In many cases trouble arose from non-metallic inclusions, often very small, in the material, and this matter should be watched carefully. Some years ago he had written a paper to show how the life of crank axles was increased by 16 per cent.; since then the life had been increased by 140 per cent., owing to the use of a tougher and a cleaner steel.

Professor Bacon, replying to the discussion, said that if he were reproducing the kind of fracture that occurred in service, he was succeeding in what he was trying to do—to help the engineer. It was noticeable that the majority of failures occurred as the result of a temperature drop. During rolling there might be an enforced stop for a short time, during which chilling occurred on the outside, and therefore initial tension was set up in the skin.

Reports of Committees.

Electrical Terms and Definitions.—Professor G. W. O. Howe, reporting on the activities of the Section's Committee on Electrical Terms and Definitions, said that the subject was one which was being considered by many committees in this and other countries. Different views were held with regard to the meaning of various fundamental terms used, and it was essential to obtain international agreement between physicists and electrical engineers. The Section's Committee must work, therefore, in close co-operation with other bodies considering the subject.

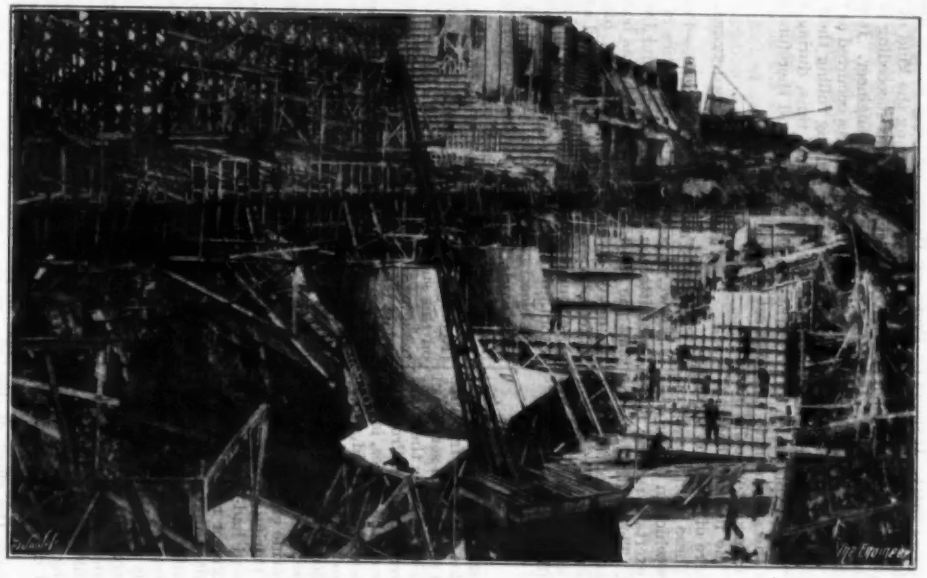
Stresses in Overstrained Materials.—Mr. J. S. Wilson (Recorder, Section G) reported that the Committee on this subject, of which Sir Henry Fowler is Chairman, was continuing its work and would submit its report later.

Earth Pressures.—The Committee on Earth Pressures, of which Mr. F. E. Wentworth-Sheilds is Chairman, submitted an interim report. The report deals largely with some work which has been carried out by Professor C. F. Jenkin at the Building Research Station at Garston, the whole of which was described in a paper delivered before the Institution of Civil Engineers in February of this year. The Committee expressed the view that the research by Professor Jenkins is likely to be of great value, and recommended that his and its work be carried on for a further period.

In America the manufacturers of electric refrigerators and the electricity supply companies are collaborating to offer to purchasers of refrigerators "free electricity to operate your refrigerator for more than three months." The *Electrical Review* points out that the 100-kWh thus given away costs very little, but the price of electricity has a fascination for the consumer that is often quite out of proportion to its relative importance.

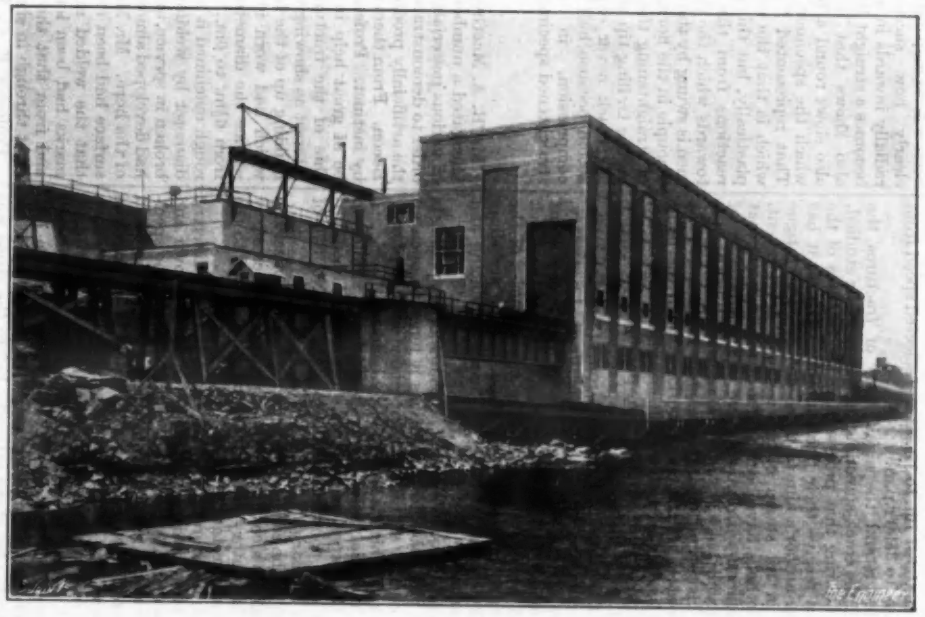
CHATS FALLS HYDRO-ELECTRIC POWER DEVELOPMENT

(For description see opposite page).

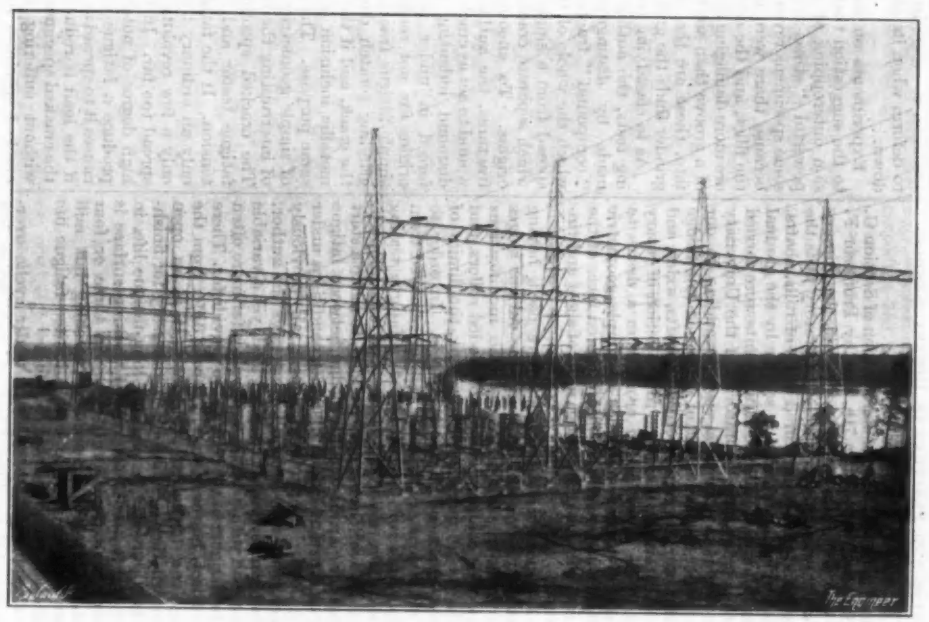


ERECTION OF POWER-HOUSE FORMS

UPSTREAM VIEW OF SLUICE GATES AND POWER-HOUSE



POWER-HOUSE



SWITCHING STATION

The Chats Falls Hydro-Electric Power Development.

ONE of the largest hydro-electric developments in Canada, the Chats Falls plant on the Ottawa River, about 36 miles upstream from the City of Ottawa, is now rapidly nearing completion. It is a joint undertaking of the Hydro-Electric Power Commission of Ontario and the Ottawa Valley Power Company, of Montreal, Quebec, and when finished will have ten units, each of 28,000 horse-power, operating under an average head of 53ft. The total output of the station will be taken by the Ontario Hydro-Electric Power Commission, which has already completed a steel tower transmission line connecting the development with Toronto, a distance of about 200 miles. The generators deliver 25 cycle power at 13,200 volts for transmission to Toronto. Of the ten units projected, eight will be installed in accordance with present plans, four of which were placed in commercial service in October, 1931, while the other four will be ready by October of this year. Illustrations of the undertaking are given herewith and on page 300.

The main dam has a crest length of over 3 miles, but it is nowhere of great height, and its situation is such that it not only involves the least capital cost, but it also serves the purpose of providing a deep-water forebay, a desirable feature in view of the low temperatures prevailing in the winter months at the site. The river banks are relatively low, and it was necessary to extend the wings of the dam upstream on each side, which results in a structure roughly horseshoe-shape in plan. At high rates of flow in the river, the head will be materially reduced, and may become as low as 38ft., and will range from this limit to 58ft. under best conditions. The structures have been designed for a regulated head-water elevation of 247·0 above sea level datum.

Chats Falls, in its natural condition, lay between two lake-like expanses of the river, the upper one of which is Chats Lake and the lower Lake Deschenes. The difference in the elevations of these two lakes under normal conditions was about 50ft., made up of a gradient of 12ft. in the 3 miles from Chats Lake to Chats Falls, and 38ft. at the site. The additional head will be made up by raising Chats Lake to its normal high-water stage. In order to locate the earth dyke on favourable ground on the Ontario side of the river, it was necessary to divert about 2¼ miles of the track of the Canadian National Railway.

MAIN DAM.

The structures comprising the main dam include an earth dyke, 4500ft. long on the Ontario side of the Ottawa River, which forms the boundary between the provinces of Ontario and Quebec, followed by bulkheads and stop-log sluiceway sections to the power-house in midstream. Between the power-house and the Quebec side of the river there are, in the order given, four sluice gates, a log slide, a bulkhead section, and a stop-log sluiceway section, ending in a shallow concrete wall on rock foundation. The total length of these structures, without the power-house, is 16,600ft., and with the power-house, 17,228ft.

The earth dyke on the Ontario side is a clay embankment, compacted by rolling, and protected against wave action by heavy riprap. It is keyed to the concrete bulkhead section by a specially designed abutment section. The gravity or bulkhead section of the dam has a top width of 5ft. and a vertical upstream face. The downstream face is vertical for 5ft. and then slopes at a batter of 8 in 12. The upstream side at the top of the wall is provided with a handrail and with lighting standards, spaced approximately 72ft. apart. There are seventy-four stop-log sluiceways, 18ft. wide by 23ft. deep, in the entire dam. On the Ontario side there are forty-two and on the Quebec side thirty-two. The flow through the sluiceways is controlled by timber stop logs, and at each group of sluiceways the logs are handled by a travelling spud winch. In addition to this control there are four sluice gates, situated immediately to the westerly or Quebec end of the power-house. These gates are of structural steel of the fixed roller type, and are 25ft. high by 40ft. wide. The gates, together with the gains in which they operate, are provided with electric heaters to assure facility of operation in the severe winters which prevail in the district.

MISSISSIPPI RIVER DAM.

The Mississippi River, a tributary stream, joins the Ottawa a short distance above the dam on the Ontario side, and at high stages discharges, in part, through a channel generally parallel to the Ottawa. To control this discharge there were built two small concrete dams, one of which is provided with stop-log sluices.

POWER-HOUSE.

The power-house is situated with its transverse centre line on the inter-provincial boundary, and, as at present constructed, contains eight of the ultimate ten units; one of the remaining two will be placed at the Ontario end of the station and the other at the Quebec end. The length of the station as now built is 500ft., and, when completed for the ten units, will be 628ft. The power-house intake structure or head-works is incorporated in the main dam, and contains three water passages for each of the ten units. Steel head gates of the fixed roller type operated by motor-driven cable hoists, are provided for shutting off the water to the units. Structural steel racks in removable sections are arranged immediately downstream from the curtain wall, and gains or checks for emergency steel gates are situated between the racks and the head gates. The hoists for the head gates are housed in a low structure incorporated with the superstructure of the main power-house, and when it is desired to remove the gates for repairs or inspection, they may be transferred from their suspended position and taken out through an opening outside the hoist housing by a travelling gantry crane, which is provided not only for this purpose, but to handle racks, emergency gates, and other equipment. The emergency gates are stored in the checks at Nos. 1 and 10 units, where they are readily available for immediate removal and placing by means of the travelling gantry.

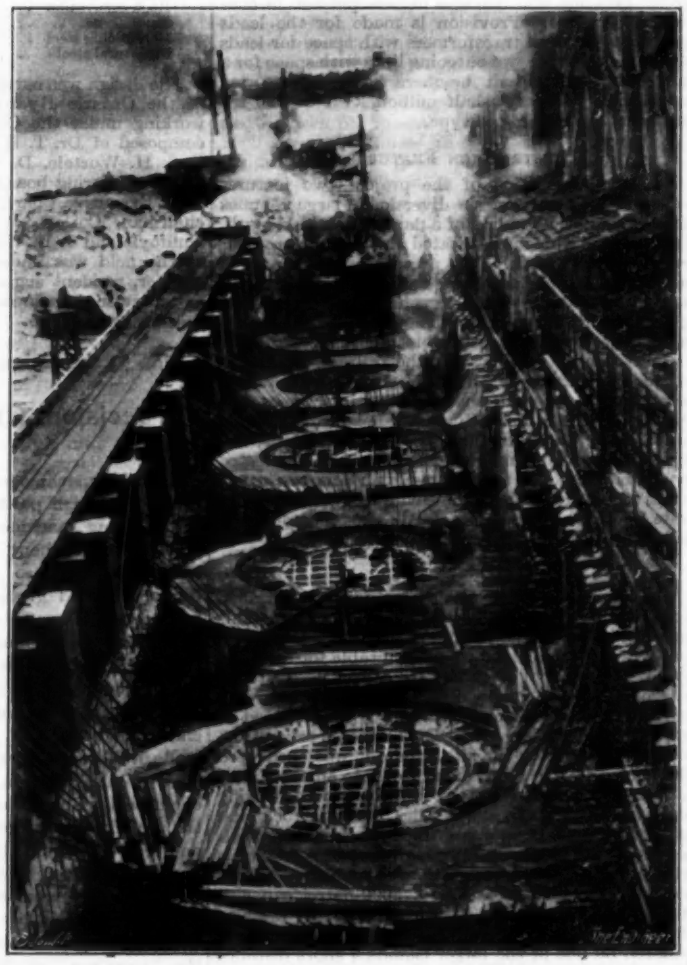
The substructure encloses the scroll cases and elbow type draught tubes, all of which are of reinforced concrete. The draught tubes project 30ft. beyond the downstream wall of the power-house. Over this projection is provided a standard gauge track to enable the placing of steel stop-logs by a locomotive crane to unwater the draught tubes. In the substructure, just below the generator floor level, there are two air ducts per unit for the supply of the necessary cooling air for the generators. Openings into these air ducts are also provided through the generator floor, with louvres to regulate the air circulation.

The superstructure framework, in which is incorporated the runway for the travelling power-house cranes, is of structural steel. The walls of the building are of reinforced concrete, and the exterior presents a pleasing appearance, the lower façade containing fluted pilasters, between which large windows are provided. The interior walls are painted, the colour scheme selected for the painting of the equipment harmonising with that for the interior. The floor of the generator room, which is the main operating floor, is 47ft. wide and 496ft. long, as at present constructed. It is surfaced with Welsh quarry tile. The intake structure forms the upstream wall for the power-house, and between this wall and the generator room proper are three gallery floors, 20ft. wide, which serve to accommodate auxiliary and service equipment, 13·2-kV switchgear, battery rooms, control room, and offices.

EQUIPMENT.

The hydraulic equipment comprises eight vertical propeller type turbines with fixed blades rated at 28,000 horse-power under 35ft. head and operating at 125 r.p.m. Each turbine is controlled by a Morris-Felton governor electrically operated and situated on the main generator floor upstream from and between the generators. The governors are provided with

GENERATOR ROOM



ERECTION OF GUIDE VANES

individual oil pumps and accumulator and sump tanks which are placed 2ft. above the main floor. The units are interconnected in pairs.

The eight generators are spaced at 62ft. centres and are rated at 23,500 kVA, 13·2 kV., 85 per cent. power factor. The main and pilot exciters are directly connected to the main unit shafts. The generators are connected in pairs through 13·2-kV switchgear, two 1,000,000 circular mils lead-covered single conductor cables per phase being used. For the connection from the switchgear to the transformers, situated just outside the power-house behind the dam, four similar cables per phase are employed.

The control room is situated at the centre of the power-house on the third floor level, which is 31ft. above the main generator floor. In this room is centred the control for both the generator station and the transformer station. On the control desk, which occupies a floor space of 140in. by 40in., are mounted ninety-four miniature control switches which operate a 48-volt D.C. system, which in turn operates the main 250-volt D.C. control for the generators, oil switches and transformers. On the same floor as the control room are the storage battery rooms, offices, store rooms, electrical repair shop, and air treating room for the air for the offices and control room. The 220-kV switchyard occupies a space measuring 300ft. by 360ft. and is approximately 800ft. from the power-house on the Ontario side. In this yard are situated nine oil circuit breakers and bus and motor-operated disconnecting switches. Provision is made for the leads from four banks of transformers with space for leads from a fifth and for two outgoing lines with space for a third. The oil circuit breakers have a rupturing capacity of two and a-half million kVA at 220 kV and are of the Deion grid type.

Construction Features.

In the construction of the project two features peculiar to the site were the diversion of large volumes of water and the building of a dam of unusual length. These two features necessitated the use of numerous and long cofferdams. The presence, however, of a number of islands and rock ridges scattered in the river simplified the diversion scheme and because of the natural drainage below the cofferdams the pumping was reduced to a negligible quantity, excepting for the tailrace section. In the tailrace cofferdam, where a maximum depth of 25ft. was found, it was necessary to use steel sheet piling to secure watertightness. The comparatively low height of the main dam greatly facilitated the concreting operations, and it was found that a material saving could be effected by the building of a timber trestle for a narrow-gauge construction track along the entire length of the concrete section of the dam. All the concrete was delivered on and placed from this trestle.

Concrete.

The coarse aggregate for all structures was obtained from the excavation for the power-house. This material was a hard durable granitic gneiss of good quality. It was blasted to sizes suitable for handling by power shovels of 1¼ cubic yard capacity. The rock was loaded into 6 cubic yard dump cars and delivered to the crushers and screens, where it was reduced to suitable sizes for concrete. The sand was taken from a pit 39 miles from the site, where it was excavated and loaded by a dragline excavator into 40 cubic yard cars and delivered to a stock pile close to the mixing plant. Beneath the stock piles of both rock and sand were tunnels through which were operated belt conveyors leading to the mixing plant bins. Cement was purchased in bulk form and unloaded mechanically through chutes into a 3000-barrel capacity storage bin, from which it was conveyed by belts to the mixing plant. The mixing plant was centrally situated on one of the larger islands a short distance downstream from the dam and about 250 yards west of the power-house. It contained two mixers of 2 cubic yard capacity each. Sand and stone were fed through gates to a batch hopper mounted on weighing scales. Cement was weighed on a separate scale to obtain greater accuracy. Water was weighed in a steel tank, also on a separate scale. Each batch was mixed for a minimum of two minutes as timed by a specially designed timing clock. In the field laboratory two recording wattmeters were connected through a current transformer to one phase of the electric motors operating the mixers and gave a graphical record, not only for each batch, but for the day's operations.

A close system of concrete inspection was carried out under the control of a chief inspector and a staff of nine assistants. Concrete was transported to the work by trains of 1 cubic yard V-dump cars, or in 6 cubic yard standard-gauge dump cars. Every effort was made to avoid horizontal construction joints, as these joints have been found to cause deterioration of the concrete as a result of seepage through them. The headworks piers, which are 60ft. high, were built without a horizontal construction joint, but this method necessitated great care in placing, the rate of which was reduced at times to 5ft. per hour to safeguard the forms and minimise shrinkage.

Winter Conditions.

In the winter of 1930–1931, during which the construction was actively carried on, the lowest temperature recorded was 22 deg. Fah. During this period the requirements for the concrete comprised its delivery and placing at proper temperatures and its protection from freezing during the curing, which was of seventy-two hours' duration. Only the sand and water were heated as the cement when delivered to the mixer had a temperature averaging over 70 deg. Fah. The mean temperature of the water entering the mixers was, in January, 144 deg. Fah. The sand reached the batch hopper at 105 deg. Fah. and the concrete leaving the mixer had an average temperature of 82 deg. Fah. The power-house forms were protected by enclosing the whole area being poured by a light timber frame covered by drier felt, a material discarded by paper mills. The average temperature inside the forms for January was 42 deg. Fah. Winter protection was maintained from the end of October till the middle of April.

The general construction work was carried out by Morrow and Beatty, Ltd., of Peterborough, Ontario, who began work in October, 1929. Preliminary construction of camps, roads, and railways was largely done during the winter of 1929–1930. Active construction was started as early as the climate would permit in the spring of 1930. Concrete work was under way by July, 1930, and the power-house was completed by the end of September, 1931.

The work involved the following major items :—

Cofferdams	92,000 cubic yards
Concrete	243,000 ,, ,,
Rock excavation	272,000 ,, ,,
Earth dyke	166,000 ,, ,,
Reinforcing steel	3,100 tons
Structural steel	1,500 ,,

The design was carried out by the engineering staff of the Ontario Hydro Electric Power Commission, working under the Chats Falls Engineering Board, composed of Dr. T. H. Hogg, chairman, and Messrs. J. S. H. Wurtele, D. Stairs, and E. T. J. Brandon. This engineering board was responsible to the Chats Falls Executive Board, consisting of Dr. F. A. Gaby, chairman, Col. C. W. Allen and Messrs. H. E. Guilfoyle and J. B. Woodyat. The engineering work in the field was under the direction of Col. H. L. Trotter, resident engineer ; and Mr. O. Holden was co-ordinating engineer of the project with headquarters in Toronto.

Precision Grinding Machines.

No. I.

Of all the machine tools that have made present-day methods of high production at cheap cost possible, the grinding machine can unhesitatingly be given first place. Without it that degree of interchangeability which is so absolutely necessary if mass production and group production methods are to be successful, would be very nearly impracticable. Apart from its inestimable value in mass production the grinding machine by increasing the accuracy with which parts of machinery can be constructed has done much to improve the performance of an enormous variety of productions which cannot be made in the mass. There is no need to quote examples, since grinding finds a place in nearly every field of engineering. In another direction it has made possible the use of parts hardened to a degree such that only an abrasive could reduce them to the required size and has so given to the designer the opportunity of increasing the wear-resisting properties of his productions.

Considering that the grinding machine is among the " youngest " of the tools that man has invented, it is not surprising to find that it has not yet reached its full development. Statistics given in the *Board of Trade Journal* for June 9th this year abundantly illustrate this fact. There is tabulated therein a comparison for the years 1930 and 1924 respectively of the production in this country of a number of machine tools, including drilling, grinding, milling, planing, and shaping machines, lathes and presses, and similar machines. In many cases the weight of the machinery constructed in each of the two years is only partially known, but the figures for values are complete. These figures show that in 1924 the value of the grinding machines constructed in this country was £268,000, while the corresponding figure for 1930 was £522,000, an increase of 94 per cent. This figure is only surpassed by that for lathes at 103 per cent. The figures for weight of production in 1924 are not complete, only 38 per cent. of the value being represented by a corresponding weight. If this proportion of the total weight of production is taken to be representative the value per ton weight of grinding machines made in 1924 was £68, compared with a corresponding figure of £147 for 1930. It is hardly open to question, therefore, that the present-day grinding machine is a more expensive article than its predecessor. Part of the increase can probably be traced to the use of electric motors for driving purposes, while the rest, it seems not unlikely, is caused by an increase in the accuracy of the workmanship and the convenience of the machine.

In this series of articles many typical grinding machines, some put on the market within the last few months, will be described, both of the type capable of tackling the ordinary " run-of-shop " job, and of the kind particularly suited for one operation. As regards the latter, it would be impossible in such a series as this to do more than indicate the range available. Machines are constructed for the grinding of crank shafts, cams, locomotive piston-rods, locomotive cranks, railway wagon axles and journals, motor car engine cylinders, poppet valves and a host of other parts. Each has its own peculiarities of construction to meet its particular requirements. Machines suitable for the grinding of gears form another large group to which but little reference can be made, while the class of tool and cutter grinders is in the same position. Though there is much of interest in the mechanical construction of grinding machines for roughing work, such as the fettling of castings, space precludes any reference to those that are not constructed for precision work. In the classes of tool that are not thus excluded, however, there is much of great interest, and it may be said with truth that the majority of one-purpose grinding machines are constructed on a common principle, the variations from the normal design being but differences in the arrangement of the working parts and other necessary, but not fundamental, modifications.

Abrasives.

Although grinding as a means of polishing and shaping metals and other materials is a process of very primitive origin, its development to the stage of high importance which it now occupies in the engineering industry has occurred within the past thirty years or so. Like the gear-box, the modern grinding machine owes much to the motor car, for it was primarily to meet the demands of the automobile engineer that the precision grinding machine was evolved.

So long as grinding was performed by means of sandstone wheels, little progress was possible. In Moh's scale of hardness quartz occupies seventh place :

Moh's Scale of Hardness.

1, Talc ; 2, Rock Salt ; 3, Calcite ; 4, Fluorspar ; 5, Apatite ; 6, Felspar ; 7, Quartz ; 8, Topaz ; 9, Corundum ; 10, Diamond.

Any mineral in this scale scratches those of lower number, and is scratched by those of higher number. Not only is sandstone deficient in the hardness of its particles, but the strength of the bond holding them together sets a low limit to the peripheral velocity at which a natural sandstone wheel can be rotated. In addition, the texture of the natural stone varies to an extent which is incompatible with highly efficient operation.

The first step taken in the direction of improving upon the natural stone was made by Ransome in this country, who, in the 'sixties of last century, developed an ingenious process for the manufacture of artificial sandstone wheels which were distinguished by the uniformity of their texture. Ransome's stones were, however, soon displaced by wheels manufactured from emery and natural corundum. The mineral known as corundum or adamantine spar is in its common form a transparent blue to brown tinted crystal found in India and elsewhere and consisting of about 90 per cent. of aluminium oxide, Al_2O_3. In purer forms it occurs as a variety of gem stones, of which the ruby and the sapphire are the most important. Emery obtained principally from Eastern Mediterranean countries and notably from the island of Naxos is in its natural state a rock-like substance consisting of about 70 per cent. of granular corundum in a matrix composed largely of magnetic iron oxide.

It is stated that artificial wheels made from crushed emery held in lac were in use several centuries ago in India and China. Round about 1880 successful efforts were made to produce artificial abrasive wheels from emery and natural corundum with a pottery mixture as a bonding material. With the introduction of these wheels grinding as an industrial process began to develop. Difficulties, however, were soon encountered, because it was found to be next to impossible to guarantee that successive batches of the wheels would maintain a standard quality. The emery deposits yielded a mineral which was not of uniform constitution even when obtained from one and the same source. The corundum deposits exhibited a still greater variation. In addition, the emery wheel suffered seriously from the " glazing " which it developed in use. That glazing was traced to the high content of iron oxide in the emery. It led to the heating of the work and a consequent lack of precision. Natural corundum wheels were less affected by this trouble, but they were still so far from perfect that prolonged research was directed towards discovering a substitute for natural abrasives.

The electric furnace was at that time beginning to take commercial form, and it was with its aid that the search was carried out. Success was achieved in 1893 by Dr. E. G. Acheson, who had been working in Western Pennsylvania with a small electric furnace

in a direct search for a method of producing an artificial abrasive. The small brilliant crystals which Acheson produced and which were found to be high in the scale of hardness were not immediately recognised to be what they were, namely, crystals of silicon carbide, a material which does not occur in Nature. The new material was called "carborundum," a somewhat unfortunate name, in that it suggests a relationship with corundum, a body of a totally different chemical composition.

After many difficulties the Carborundum Company, formed to develop Acheson's discovery, established the process on a manufacturing basis at Niagara Falls, a site selected in view of the plentiful supply of hydro-electric energy which it afforded. The manufacturing process is comparatively simple, although it requires a considerable nicety of control. Silicon carbide, SiC, is formed by the reaction between sand and metallurgical coke when subjected to the temperature of an electric furnace. A little sawdust is commonly added to the mixture of the raw materials, the object being to render the mixture porous and thereby to facilitate the escape of the great quantities of inflammable gas which the reaction generates. The furnaces employed are in the form of brick boxes, 20ft. or more in length, with the electrodes in the ends. The ground mixture of silica, coke and sawdust is packed into the furnace, and between the electrodes there is laid a conductor of granular coke. On top of the conductor more of the mixture is placed. When the run is completed the original granular carbon conductor is found surrounded by a mass of silicon carbide crystals, outside which there is a layer of "fire sand" consisting of a partially converted mass, and still farther outside a layer of the raw materials in their unconverted state.

The original patents covering the manufacture of carborundum have now expired and the material is made to-day in several countries under various names. In addition to carborundum the material is known as carbolite, carbolon, carbora, carbosolite, carbowalt, corex, crystolon, dicarbo, electrolon, gresolite, and sterbon. None of these names seems quite appropriately to describe a substance which consists simply of silicon carbide.

It was soon found that silicon carbide was not suitable for grinding all classes of metal. It was most highly efficient when dealing with brittle materials, such as cast iron, marble, brass, and metals of low tensile strength. It is itself very hard and brittle and in use its grains suffer constant fracturing, and fresh cutting edges are exposed which score deeply into tough material, such as steel. The commercial production of carborundum did not therefore result in the immediate disappearance of emery and corundum wheels. In 1897 steps were taken to open up a fresh line of advance in the production of artificial abrasives. These steps consisted of an attempt to produce artificial corundum, the natural supplies of which were by then beginning to show signs of exhaustion. The pioneering work in this direction was done by Mr. C. B. Jacobs in the laboratory of the Ampere Electro Chemical Company in New Jersey. The process employed consisted of the fusion in the electric furnace of the mineral bauxite, a substance which consists largely of hydrated aluminium oxide in the non-crystalline form.

Bauxite in its native form contains in addition to aluminium oxide and water the oxides of various metals such as iron, silicon and titanium, and other impurities. After it has been heated to drive off the water it is smelted in an electric furnace. If coke is added to the charge the metallic oxides are reduced and the metals collect as a button at the foot of the furnace. The product is then commercially pure crystallised artificial corundum. Other purifying agents may be added in varying degrees. By the control of the smelting conditions, products of different grades may be obtained varying from pure corundum to corundum containing as great a percentage of impurity as the original bauxite.

The manufacture of artificial aluminous abrasives or corundum was begun on a commercial scale by the Norton Emery Wheel Company at Niagara Falls in 1901. The original patents having expired, the material is now produced in various countries under a large number of names, of which, perhaps, aloxite and alundum are the two best known. In nearly every case the smelting of the bauxite is carried out in electric furnaces of the arc type. In a widely used form the furnace consists of a cylindrical sheet steel shell mounted on a carbon base. Carbon electrodes are suspended within the shell, and during a run the current arcs from one electrode to the surface of the charge, and thence to the other electrode. The shell is not lined. During the smelting process water is sprayed continuously over its outer surface, with the result that the layer of the charge adjoining the shell is cooled and forms an effective lining.

As an abrasive crystallised aluminous oxide is less hard than silicon carbide. It is, too, less brittle. The grains being tougher do not break so readily and, therefore, can withstand a greater stress. Hence, as a broad general rule aluminous abrasives are suitable for grinding materials having a high tensile strength, and silicon carbide abrasives for materials having a low tensile strength. In addition, the character of aluminous abrasives can be controlled to a marked extent by the process of manufacture, and, in particular, by the completeness or otherwise with which the slag is removed from the crystallised aluminium oxide. The variation possible in this respect in the case of silicon carbide is comparatively small.

Whether the abrasive is aluminous or silicious the product of the electric furnace—a coherent mass of crystals—is passed through jaw crushers and then through a series of rolls which reduce it to particles of varying size. Screens are employed to separate the different sizes, and during the crushing and separating processes particles of iron which may be present are removed magnetically. The material is then washed to remove dust, dried and passed through a final separating plant. The grain sizes normally produced range from material passing through a screen having 8 meshes per lineal inch down to material capable of passing a screen with 200 meshes per inch. Sizes finer than No. 200 are known as "flour" and are separated hydraulically.

Abrasive Wheels.

The crushed and graded abrasive has now to be made into a wheel. Four processes are practised, each of which possesses its own merits. By far the most usual type of wheel is that made by the vitrified process—that is to say, by a process in which the abrasive grains are bonded together by means of a felspar and clay pottery mixture. To a certain extent the hardness or "grade" of a wheel can be controlled by varying the composition of the bonding mixture. In general, however, the "grade" is determined by the amount of bonding material relatively to the amount of abrasive, a soft grade, such as that designated F, having a greater proportion of bond in its composition than a hard grade, such as that called R. The pottery mixture, very finely ground, and the abrasive material in the correct proportions, are thoroughly incorporated in the presence of water in a mixing machine. The mixture is then drawn off into moulds consisting of cylindrical sheet steel bands placed on plaster slabs. Thereafter the filled moulds are dried under very carefully controlled conditions, the drying process occupying from twenty-four hours to a week, or even several weeks in the case of the largest sizes of wheels. The wheel blank, after drying, is shaved to size on a machine very similar to a potter's wheel, the shaved dimensions including an allowance for subsequent shrinkage and final truing. During the shaving process the hole is formed in the wheel. After shaving, the wheels are placed in saggars and burned in a coal-fired kiln. The burning operation may last from five to sixteen days, depending upon the size of the wheel and the amount of bonding material in its composition. When the burning is completed the kiln is sealed with fire-clay and is allowed to cool slowly for the purpose of annealing the contents. The wheels on removal from the kiln are mounted on lathes and trued all over by means of a diamond or a hardened conical steel cutter of the Huntington type. Thereafter, they are bushed with lead or other soft material. Wheels 12in. or upwards in size are generally tested for balance, any lack of which is corrected by removing a portion of the wheel in the neighbourhood of the hole and filling the cavity with lead. Finally, all wheels 6in. and over in diameter are tested for strength by running them at a speed about 50 per cent. in excess of their working speed. The actual grade of a wheel is not assigned to it until after it has been fired. The grading is done by means of a tool which is pressed against the wheel and twisted slightly, the grade being judged by the resistance offered to the twisting motion. Judgment is assisted by comparative tests on wheels of known grade. The process is one demanding great skill and experience on the part of the operator. It is still largely conducted entirely by hand, although some manufacturers have developed machines to assist in its performance.

Vitrified wheels possess a bond of great strength. Their structure is porous and if they are correctly made they are free from hard and soft spots. The process, although it is adopted in the case of about 75 per cent. of the wheels produced, is, nevertheless, one which requires high skill and the expenditure of much time. In particular the drying and burning operations cannot on any account be hurried. An alternative method of manufacture which is more rapid and which permits special wheels to be made in a few days, is the silicate process. In this process the principal constituent of the bonding material is silicate of soda, or water glass, to which various fillers are sometimes added. The mixture is tamped into a mould and after the blank has been dried it is baked at a comparatively low temperature. The wheel is finished to size, graded, balanced, and bushed in the same manner as in the case of a vitrified wheel. In this process no shaving operation is necessary. The grade of the wheel is determined not only by the amount of bonding material employed, but also by the degree of tamping given to the mixture in the mould. It is stated that whereas the average length of time occupied in making a vitrified wheel is about six weeks, a silicate wheel can be made in four days. Silicate wheels are milder in their grinding action than vitrified wheels, and are, therefore, esteemed for grinding tools, knives, saws, and other work in which it is important not to draw the temper.

A third form of wheel is the so-called elastic type. The bonding material in this case is shellac. The abrasive material is incorporated in the shellac in a steam-heated mixer. The forming process consists of pressing the mixture into steel moulds. Thereafter, the blanks are placed in sand and baked for a few hours at a temperature of about 300 deg. Fah. The process permits very thin wheels to be made. It is rapid and easily controlled, but the wheels produced are less porous than vitrified wheels and are incapable of withstanding much heat.

The fourth process makes use of rubber as the bonding agent. The abrasive material is incorporated in pure rubber to which sulphur is added for vulcanising purposes. Leaving the mixing rolls the material is passed through a calender which spreads it out into a sheet of the required thickness. From this sheet the wheels are cut by means of a die. They are subsequently heated under pressure to vulcanise the rubber. By this process very hard, tough, thin wheels can be produced.

From this account of the production of abrasive wheels it will be seen that manufactured abrasive wheels may differ from one another by virtue of a difference in the nature of the abrasive material, in the size of the abrasive particles—that is to say, in their "grit"—and in the nature and amount of the bonding material—that is to say, in their grade. A very wide variety of wheels is, therefore, offered to the user, and there is much opportunity for the exercise of judgment in deciding upon which wheel will prove most economical and efficient in any given circumstances.

Recently it has been found that for snagging and fettling operations several advantages can be obtained by the use of bakelite bonded wheels. The normal vitrified wheel will run at speeds up to about 5000 surface feet per minute, whereas speeds as high as 9000 surface feet per minute are possible with bakelite-bonded wheels. The method of producing such wheels employed by B. R. Rowland and Co., Ltd., of Stockport, is to mix suitable proportions of abrasive grain and powdered bakelite resin into a homogeneous whole. The mixture is then compressed in a suitably shaped mould by hydraulic power until the correct density is reached. Finally the wheels are baked in an electrically-heated oven. At present the new wheels do not seem to have been used for precision grinding, although for some time they have been used in the foundry and smiths' shops. Their advent has caused special machines such as that described on another page of this issue capable of taking advantage of their properties to be built, and should they be made suitable for precision purposes it is probable that the future will see a number of modifications to the design of precision grinding machines as we know them to-day.

(To be continued.)

The Measurement of Surface Temperatures.*

By NEIL P. BAILEY.

The accurate determination of the temperature of a solid surface is a very common problem that confronts any engineer who is conducting thermal tests or experiments. Investigations of heat conduction, convection, and radiation; heat runs on mechanical and electrical machinery; and tests of heating equipment, all require the accurate measurement of surface temperatures. Such determinations are made in a great variety of ways, ranging from a mercury thermometer fastened to the surface in ordinary commercial testing to the very elaborately embedded thermo-couples used in precise experimental work.

Before any information concerning the accuracy of the various methods of surface-temperature measurement can be had, it is necessary to know positively the true surface temperature, and an apparatus consisting of an electric heater between two wrought iron plates, with the heater wound so that the heat loss per unit area of plate would be constant, was developed, and was adjusted to give an error of only one or two degrees at most.

Test Results.

With a method of determining the true surface temperatures established, attention was directed to the ordinary mercury thermometer as a means of measuring surface temperatures. Since the bulb of the thermometer is usually placed in contact with the surface and then covered with some insulating material, the first thing studied was the effect of the amount of this insulating material used.

Effect of Thickness of Thermometer Covering.—By repeatedly covering thermometers with both putty and with an asbestos-oil mixture, as one would ordinarily attach a thermometer, it was decided that approximately $\frac{1}{4}$in. of covering is the most probable ordinary thickness used, and this was taken as a standard. A thickness of $\frac{1}{32}$in. gives the thermometer a decidedly bare appearance, and one of $\frac{1}{2}$in. is rather difficult to keep in place.

With the plate in the vertical position, tests were run with these three thicknesses and with no covering. The results show that a bare thermometer in contact with the surface reads 72 per cent. of the temperature difference, $\frac{1}{32}$in. of covering raises this to 87 per cent., and $\frac{1}{4}$in. to 90 per cent.; while $\frac{1}{2}$in. of covering causes an indication of 92 per cent. of the difference. Considering $\frac{1}{4}$in. as the ordinary thickness used, gives 90 per cent. of the difference as the reading to be expected when using a thermometer for the determination of surface temperatures. This does not mean, however, that the error is 10 per cent.

* From an article in *Mechanical Engineering* (New York), August, 1932

For a surface temperature of 120 deg. and an air temperature of 70 deg., the error would be one-tenth of 50 deg., or 5 deg., which would cause an error in the determination of the total temperature of slightly over 4 per cent. In the case of a surface of 470 deg. with 70 deg. air, this would mean an error of 40 deg., or 8½ per cent.

Effect of Type of Thermometer.—The previous tests were made using a 760 deg. Fah., 12in. long, 1in. immersion thermometer, having a bulb $\frac{1}{8}$in. in diameter and $\frac{3}{4}$in. long. The insulation was extended to the point of immersion, and the thermometer was inclined at a small angle with the surface to keep the stem from coming in contact with it. The results obtained were compared with those given by a 400 deg. Fah., 14in., full-immersion type thermometer, with a $\frac{3}{8}$in. mercury bulb, $\frac{3}{4}$in. long, using the same thickness and total area of insulation as before. The stem of this thermometer was left in contact with the plate, and a stem correction was applied. It was found that within the limits of accuracy possible, the type of thermometer used has no detectable effect on the indicated surface temperature, provided each thermometer is applied in a manner consistent with its type.

If a constant immersion type is used, it should have the immersion length covered by the insulation and the stem separated from the surface. If a full immersion type is used, a stem correction should be made, considering the point of immersion as that point where the stem first touches the surface.

Effect of Covering Material.—The most common thermometer-covering materials used are putty and a plastic mixture of finely divided asbestos with oil. Tests show them to be of equal value as far as their effect on the indicated temperature is concerned. In actual use, putty has more strength than the asbestos, but becomes very hard with prolonged use, and burns badly above 350 deg. Fah., while the asbestos remains soft. Mixtures of the two in various proportions are often advantageous.

Effect of Surface Position.—Since the heat convection from a vertical surface is not the same as that from a horizontal surface, the effect of surface position on indicated temperature was studied; however, no difference could be detected between the two cases.

Surface Temperature Indications of Thermo-couples.—Since thermo-couples are very convenient to use, and are widely applied in thermal testing, their reliability as indicators of surface temperature was investigated. Two sizes of iron-constantan couples, No. 28 gauge and No. 20 gauge, were constructed with welded junctions that were carefully made as small as possible consistent with the necessary mechanical strength. They were attached to the plate by means of $\frac{1}{8}$in. of asbestos paste, care being taken that the hot junctions were placed and held firmly against the plate. It was found that the No. 28 gauge couple indicated 98½ per cent. of the temperature difference, and the No. 20 gauge couple 95½ per cent.

Conclusions.

The foregoing results indicate quite clearly that thermometers do not indicate surface temperatures with sufficient accuracy for experimental work, and that when they are used in commercial testing it should be remembered that they indicate, when referred to the ambient-air temperature, approximately 90 per cent. of the true difference between the surface and ambient-air temperatures.

On the other hand, when carefully made of small-gauge wire, and fastened to a surface with a covering of insulation, thermo-couples will indicate as high as 98·5 per cent. of the difference between the surface and the ambient-air temperatures. If a metal surface is being tested and the leads and junction are properly embedded or are welded on and covered with putty, accuracies close to 100 per cent. may be attained.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

"OVER ONE HUNDRED PER CENT. EFFICIENCY."

SIR,—If I have misunderstood the cycle described by Mr. Waring in his first letter, I submit that the fault was not mine. In fact, I still find it unintelligible. He illustrates it by a diagram which clearly shows that the gases remain at constant volume during the rise in pressure from p_1 to p_2 produced by the explosion. They are then said to be cooled down to pressure p_2 by the boiler, and to be admitted to the turbine at this pressure. The mysterious thing about the cycle is that during this cooling, the diagram shows that the gases shrink to about three-fifths of their volume. What I, and no doubt other readers would like to know, is how any contraction of volume can take place, seeing that all the time of cooling the gases are enclosed in a furnace and boiler of fixed dimensions?

I note that Mr. Waring, apparently, accepts my statement that the gases, in the example he gave, would be at less than 2 atmospheres pressure, instead of at 3·33 atmospheres, as he assumed, and that the plant, therefore, could not work.

The cycle which I assumed Messrs. Brown, Boveri's plant to work on, was the most favourable one possible and was, moreover, in accordance with the company's own description. I gave what seemed a conclusive proof that the claims made for the boiler are theoretically impossible under any circumstances, and Mr. Waring makes no attempt to refute my reasoning.

The scheme for air-heating which he now illustrates is entirely beside the point. Such a plant, of course, transgresses no Law of Nature, for in principle it is nothing more than the well-known "warming-machine" proposed by Kelvin in 1842. All that it can do is to enable us by the expenditure of power, to produce a greater number of heat units than could be obtained by the direct conversion of the same quantity of power into heat. The heat produced is, however, necessarily at so low a temperature that, in spite of its greater amount, it could not by itself furnish the power required for the process. There is no suggestion that Messrs. Brown, Boveri incorporate any such device in their plant, and if they did, it could be of no help to them.

To claim an efficiency of "well over 200 per cent. under certain conditions" for a warming-machine is a misuse of words. It is equivalent to making the same claim for a water turbine and pump which, under certain conditions, can deliver into a reservoir many times as much water as that which would fall into the reservoir by itself from the higher level. All that is done in either case is to use a high energy-head to raise a large quantity of something through a comparatively small height, and the efficiency is not to be measured by the quantity raised without reference to the work done.

I do not, however, wish to follow Mr. Waring into digressions from the simple point at issue. Messrs. Brown, Boveri have said, and they repeat their assertion in your current issue, that they have devised a way of rendering more heat available for generating steam in a boiler than is produced by the combustion of the fuel. They give no information as to where the extra heat is supposed to come from beyond a suggestion that it is derived from the atmosphere by exhausting the flue gases below atmospheric temperature.

M.I. MECH. E.

September 19th.

SIR,—Perhaps I can help to explain the meaning of what is evidently to many an alarming claim.

The proposed cycle of Messrs. Brown, Boveri ingeniously combines the action of a heat pump with that of a heat engine and boiler. Now, there is no contradiction of the Laws of Nature involved in the fact that a heat pump has a coefficient of performance greater than one. If, then, a certain proportion of the energy input is utilised in a heat engine and boiler with an efficiency less than 100 per cent. and the remainder in a heat pump with a coefficient of performance greater than one, it is obviously not impossible to arrange matters so that the heat transferred exceeds the energy input. In essentials that is all that the claim of Messrs. Brown, Boveri amounted to. I should not myself regard it as quite accurate to speak of the efficiency as over 100 per cent.; it is, at any rate, misleading and apt to raise doubts about a proposal which is fundamentally simple.

R. H. DIBB.

Leeds, September 17th.

American Engineering News.

Triple-bogie Rail-car.

THE use of rail-cars on American railways has not yet reached the commercial stage, and most of these self-contained cars are of diverse types and of a more or less experimental character. However, there are a number of cars in regular service, and experience will probably tend to a survival and continuance of the fittest. One of the latest of these machines is an articulated, double-body car mounted on three four-wheeled bogies, with petrol-electric motor equipment delivering power to the first and second bogies. The forward section of the body, 30ft. long, contains the power equipment, consisting of a twelve-cylinder V-type engine, directly connected to a D.C. generator, which serves four motors geared to the bogie axles. The engine, developing 900 H.P. at 900 revolutions, has cylinders 9in. by 12in. It provides power sufficient to haul four passenger coaches when necessary. A fuel tank of 750 gallons capacity is hung beneath the car. The rear section, 60ft. long, is for baggage, express, parcels and mail. It contains a steam boiler for heating the trailers. As all passengers are carried in ordinary coaches as trailers, this rail-car is not strictly self-contained, since it must haul at least one passenger car. With a total weight of 120 tons, there are 50 and 45 tons on the two power bogies, and 25 tons under the trailing bogie. The first two bogies have 36in. wheels and the trailing bogie 32in. wheels, all fitted with double or clasp brakes. Roller bearings are used for the axles and the motor armatures. Integral with the engine is a two-stage air compressor, which charges a main reservoir at 150 lb. pressure.

The Largest Cylinder-boring Machine.

What is said to be the largest cylinder-boring and facing machine in the United States is a machine tool built recently for simultaneously boring and facing cylinders up to 8ft. in diameter and 22ft. in length for engines and pumping machinery, particularly pumps for oil pipe lines. The bed-plate is 48½ft. long, with a table for the work measuring 23ft. by 8ft., and the entire machine weighs about 80 tons. The driving head is bolted permanently to the bed, but the other head, or tailstock, can be shifted longitudinally. A 12in. hollow boring bar, 44ft. long, passes through long sleeves in the two heads and is keyed to them, thus eliminating wear of the bar, since the sleeves revolve in the bearings, while the bar can slide through them. To support this boring bar when working on long engine beds, a gallows frame can be placed by a crane, the cross member having on its underside a bearing for the bar. Beyond the driving head are three posts on a bed-plate, to support the bar when it is withdrawn from the machine. Each post is fitted with a revolving sleeve, as is the bearing on the gallows frame. Two control stations are provided from which the motors are controlled. Lubrication by gravity feed is provided for the working parts, with splash lubrication and oil conveyors for the gear-boxes, and pressure lubrication under the sliding surfaces. A 40 H.P. electric motor drives the boring bar through a speed-change box giving speeds from 1½ to 30 revolutions per minute. An intermediate gear train drives the main 60in. gear wheel, which is keyed to the revolving sleeve in the fixed head and thus drives the bar. For power traverse there is a 7½ H.P. motor giving a speed of 16ft. per minute. The movable head is traversed along the bed by a 5 H.P. motor with a gear train driving a pinion which engages with a rack on the centre line of the bed. This machine was built by William Sellers and Co., of Philadelphia.

Rigid-frame Bridges.

Bridges of the rigid-frame type, whether of steel or concrete, are sufficiently rare to attract particular attention, and a rather striking example of this type is a reinforced concrete highway bridge in Texas. This bridge over the Comal River is 164ft. long, with a centre span of 82ft., and two side spans of 41ft., the ribs being 164ft. long. There are four ribs, two under the roadway and two under the kerbs and sidewalks, all built integrally with the roadway and sidewalk slabs and with the two piers, which are only 30in. thick. On each side of the piers there is a slab encasing the bottoms of the ribs for a short distance to resist negative bending moments. For lateral stiffness there are transverse struts between the ribs. At each abutment is another transverse strut encasing the ends of the ribs and forming the bearing upon the abutment, bronze plates being placed to permit free sliding. The ribs and their reinforcing steel are so tied into the piers that the piers resist about half the bending moment of the central span. Footings 5ft. wide form the bases of the piers, which are about 25ft. high, and as these footings rest upon a bed of solid blue clay, a rib 30in. wide was formed on the bottom as a key, to prevent slipping. A trench of exact width was cut for the footing, with the key trench in the bottom, and concrete was poured directly against the clay. The design is such that expansion and contraction movements take place from the centre to the abutments, the narrow footings acting as hinges on which the piers rock to and fro with the expansion and contraction of the spans, the piers and spans or deck forming a rigid frame or monolithic structure. The abutments are of light construction, having a 12in. wall on a 16in. bottom slab 22ft. wide, with buttresses to half the height of the wall in front and to the top of the wall at the rear. All concrete was specified for 3000 lb. strength at twenty-eight days.

SIXTY YEARS AGO.

IN our issue of September 27th, 1872, we had to record the closing down of an establishment of world-wide fame and the dispersal by auction sale of its plant and equipment. The establishment was that of the Millwall Engineering and Shipbuilding Works at Millwall, on the Thames. These works, according to our notes on their history, were founded by Napier, who subsequently left them and established himself as a shipbuilder on the Clyde. Passing into the hands of Messrs. Robinson, they were subsequently acquired by Scott Russell, and it was at them that the "Great Eastern," designed by the younger Brunel, was built. Later, under Mr. Charles Mare's ownership, rolling mills for the manufacture of armour plate were added to the works. When Mr. Mare retired a joint stock company, entitled the Millwall Iron Company, was formed to take over the works, and subsequently that firm became the Millwall Ironworks, Shipbuilding and Graving Dock Company, Ltd. Among the principal ships built at the Millwall Works, in addition to the "Great Eastern," were the ironclad "Northumberland," the P. and O. liner "Baroda," the "Rhone," which was lost in a hurricane at St. Thomas', the "Danube" for the West India Mail Company, and a yacht presented to Garibaldi by some of his English admirers. . . . In the same issue we quoted a report furnished to the *Cronstadt Messenger* by the captain of the Russian corvette "Boyarin" regarding the existing state of naval armaments in Japan. The principal vessels of the Japanese fleet at that date, it would appear, were a corvette of English construction armed with six long cast iron guns and two bronze guns, an iron-clad ram, the "Stonewall Jackson," which had formerly been part of the American Confederate fleet, and three screw gunboats of English construction. The Japanese Government was, however, bent on the development of its naval forces. To that end it had recently had constructed in the Gulf of Yeddo an arsenal situated on a terrace cut into the side of a mountain and provided with a dry dock capable of accommodating the largest ocean steamers. This arsenal was built for the Government by a Frenchman, Monsieur Verny, who had been retained as manager of the establishment and who had under him thirty of his fellow countrymen acting as foremen, assistants, and instructors. It would doubtlessly have been quite unbelievable to the captain of the "Boyarin," had he been told that a little over thirty years later the young navy of which he had seen the beginning, would inflict, under Admiral Togo, a complete and humiliating defeat on his country's fleet at the battle of Tsushima.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

COLOURS FOR GAS CYLINDERS.

No. 349—1932. This is a revision of a specification of 1931, which provided for identification colours for the gases most commonly used, the underlying principle of the scheme being that yellow should represent the toxic or poisonous gases, and red, or maroon, inflammable gases. The specification has now been extended to provide for cylinders used for medical containers for the storage and transport of such gases as oxygen, carbon dioxide, ethyl chloride, ethylene and nitrous oxide. The general scheme differentiates between the cylinders used for the more commonly used gases, but its value is, to some extent, contingent upon the general adoption of the standard valves specified in B.S.S. No. 341—1931.

Railway and Road Matters.

THE annual report, for 1931, by Sir George Newman on the health of the nation shows that there were 165,112 road accidents which resulted in 6031 deaths. The number of fatalities was, however, 614 less than in 1930. The death-rate from road accidents had risen in the decade from 7 per 100,000 of the population in 1921 to 16 per 100,000 in 1931.

THE retirement of Mr. Robert Killin, the general superintendent for Scotland, London, Midland and Scottish Railway, was assumed when the announcement was made that, under the traffic reorganisation scheme, Mr. J. Ballantyne, the chief goods manager, was returning to Scotland as chief officer for Scotland. Mr. Killin began his railway career fifty years ago when a lad of twelve.

IN view of a fall of £10,000,000 in the traffic receipts for the first thirty-six weeks of the present year, the railway companies have invited the unions to meet them in order to consider a further reduction in the men's pay with the object of obtaining "substantial relief." A meeting is expected to take place on September 30th. The last award of the National Wages Board was made in March, 1931.

THE Railway Assessment Authority which, under the Railways (Valuation for Rating) Act, 1930, is dealing with the very difficult question of the rating of railways, has just presented its report for the year ended March 31st. Incidentally, the report contains the following approximate numbers of stations in England and Wales (including halts and separate goods stations and the company's shares of joint stations):—L.M.S. Railway, 2300; L.N.E. Railway, 2000; G.W. Railway, 1500; Southern Railway, 900; Metropolitan Railway, 75; total, 6775.

AN acceleration of 114 minutes is being made by the L.M.S. Railway this week in the running of the 7.45 p.m. express freight train from London (Camden), which with a non-stop run of 191 miles to Liverpool (Edge Hill) holds the "Marathon" record for the longest non-stop journey of any British goods train. The train has now been speeded up to arrive at Liverpool 12.39 a.m. instead of 2.33 a.m.; the journey of 191 miles being performed in 4 h. 54 min., at an average speed of 39 m.p.h. This is claimed to be a remarkable performance for a heavily loaded goods train.

ON its inaugural run from Manchester to London on Monday, September 12th, the L.M.S. Railway's latest named express, "The Comet," arrived at Euston in one minute under its scheduled time of 3¼ hours. From Stafford to Euston a start-to-stop average speed of over 63 m.p.h. was maintained for the distance of 133¼ miles. The train weighed 195 tons, and was hauled by engine "No. 6165," of the "Royal Scot" class, Driver W. Walton and Fireman H. Knowles, of Longsight depôt, Manchester. "The Comet's" run opened the big winter speed-up throughout the L.M.S. system, whereby 1075 passenger trains have been accelerated by a total of 3660 minutes daily.

POSSIBLY because of the confusion between "Hawes Junction" and "Hawes," which are nearly six miles apart and the latter on a single-line branch with few trains, the former station, which carries the addition of "and Garsdale," is in future to be known as Garsdale. The serious accident there on the Christmas Eve of 1910 will, however, we expect, always be spoken of as the Hawes Junction disaster. There is frequently occasion for its mention, as it was caused by two light engines being overlooked and the incident led to the Midland Railway finding that there were 2000 places on that system where a similar oversight could readily occur. The remedy was to provide track circuit and that not only was done by the Midland, but all the other companies followed the example.

THE L.M.S. Railway announces the introduction of a system of one-day freight transits to and from the outer suburban districts of London, Birmingham and Manchester. Fast road motor services will, where necessary, be utilised to transport goods between outlying districts and the central freight depôts, where the traffic will be loaded direct on to or off the express goods trains. In the London area the districts which are now to have a "one-day transit" service to and from all parts of the country include Barking, Dagenham, Hornchurch, Romford, Upminster, Bromley, Charlton, Lewisham, Plumstead, Brockley, Eltham, Lee, Kidbrook, Wandsworth, Clapham, Chiswick, Brentford, Richmond, Twickenham, Hounslow, Manor Park, Forest Gate, Wood Green, Palmers Green, New Southgate, Edmonton, Harrow, Pinner, Hendon, and Wembley. In the Manchester area the scheme embraces Ashton, Broadheath, Denton, Didsbury, Middleton, Oldham, Patricroft, Radcliffe, Stockport, Delph, Stretford, Swinton, Walkden, and Weaste. Birmingham districts affected are Soho, Spon Lane, and Oldbury.

IT was twenty years ago on September 17th since an express train from Chester to Liverpool, just after having crossed Runcorn Viaduct, was turned on to the slow line at Ditton. The train was driven by a man who was an extra driver and whose acquaintance with the road "was not extensive." He had always passed through Ditton on the fast line. The fireman had only been that way once and the guard, as Sir Arthur Yorke said, made the usual excuse, "which has done duty on so many occasions," that he had a great deal of luggage to deal with and therefore was unable to watch the running of the train. No specific speed limit was laid down for crossing on to the slow line beyond the standard rule that such movements must be made at a speed not exceeding 15 m.p.h. As the driver maintained the normal speed of about 50 m.p.h. the whole of the train was derailed and wrecked. Three coaches were subsequently destroyed by fire and thirteen passengers, the driver and fireman were killed. The report of Sir Arthur Yorke said that the principal lesson of the disaster was the urgent necessity for ensuring that drivers were properly acquainted with the road over which they had to work. He further advised that the distant signal for leading on to the slow line should be removed; that there should be only one distant and that should apply to running through on the fast line. As the vehicles that were destroyed by fire came to rest some distance from the engine there was no question but that gas was the cause of the fire.

Notes and Memoranda.

THE physical strength testing machines of the new Berkeley University, California, include nine universal machines, with capacities from 1400 lb. up to 4,000,000 lb.

THE rails of the old slipway at Capetown are being renewed, after having been in service since 1869. The slipway is capable of hauling up vessels of 700 tons weight.

THE electrically driven turntable of the South African Railways at the recently completed Waterval Boven coaling plant is capable of turning locomotives weighing 250 tons.

THE recently opened bridge across the Clarence River in the Northern Rivers District of New South Wales is of the double-deck type, and has a bascule opening. The total length is 1510ft., composed of five 240ft. spans and a bascule of 84ft., giving a navigable fairway of 36ft. The depth of water in the channel is 44ft.

PENDULUM observations by the Canadian Dominion Observatory, Department of the Interior, show that the mountains of British Columbia are buoyed up by abnormally light material extending down into the earth's crust for about 60 miles. The excess of gravity revealed by the pendulum on the Prairies is believed to be due to an extensive underground ridge of abnormally heavy rock.

IN order to commemorate the work of the late Mr. William James, the first Honorary Treasurer and one of the founders of the Society, the Council of the Electro-platers' and Depositors' Technical Society has decided to inaugurate two annual prizes for the best essays or papers written by a student, apprentice, learner, or other young person connected with or interested in the electro-deposition of metals.

A PROCESS for the "extrusion" of metals by an impact process has been developed by the Aluminium Company of America. The idea is that a slug of the metal should be placed in a closed die and struck by a punch of the cross section of the receptacle to be formed. The slug is thinned out at the bottom by this blow and the surplus metal flows up the sides of the punch to form the walls of the receptacle. It is claimed that by these means a much deeper article can be formed in one operation than is possible with the ordinary system of drawing.

TESTS made at the U.S. Naval Experiment Station on sixty-four samples of protective coverings for tank plates, which included paints, combinations of paints, primers, varnishes, oils, sprayed metals, and cement wash, resulted in finding only one satisfactory coating, described as follows:—The coating consists of a red lead-chromate primer mixed with a specially flexible vehicle, and an outer coating of aluminium varnish. It allowed no corrosion to form on the test plates and its surface remained hard and smooth. The test samples were submerged for thirty days in two baths of condensate, one containing less than 0·3 gr. of chlorine per gallon and held at 170 deg. Fah. for eight hours a day. The second bath was made of condensate containing 0·5 per cent. normal alkalinity and 25 grains per gallon of salinity and held at 120 deg. Fah. for eight hours a day.

THE total capacity of the main generating sets in the South African Electricity Commission's five power stations at the end of the year 1931 amounted to 227,350 kilowatts. Since that date the installation of an additional 12,000 kilowatt turbo-alternator in the Congella (Durban) power station has been completed and an order placed for a new 20,000-kilowatt set for the Salt River (Capetown) power station. These extensions will increase the total capacity of the Commission's generating plant to 259,350 kilowatts (348,000 H.P.). The initial installations in these five power stations, the construction or acquisition of which was completed within the past six years, was 175,350 kilowatts, so that the increase in generating plant capacity (when the Salt River power station extension is completed) will amount to 84,000 kilowatts, representing an increase of 48 per cent. within a matter of seven years.

AN electric boiler of 55,000 horse-power has just been put into full operation at the Wayagamack mill of the Consolidated Paper Corporation, Ltd., at Three Rivers, Quebec. It will supply up to 120,000 lb. of steam per hour, or nearly sufficient to operate the entire mill. Another 55,000 horse-power electric boiler has been put into operation at the paper mill of the Anglo Canadian Pulp and Paper Mills, Ltd., at Limoilou, near the City of Quebec. This is the second unit of this size in operation in the Anglo Canadian mills, and the two boilers together will supply up to 240,000 lb. of steam per hour, or the full requirements of the mill. Another electric boiler of 33,000 horse-power capacity is being installed in the plant of the St. Lawrence Paper Mills Company, Ltd., at Three Rivers, and will be put in operation about November 1st. The addition of these units to the system of the Shawinigan Water and Power Company brings the total capacity of the electric boilers installed up to 525,000 horse-power.

THE Secretary for Mines announces the publication of Mr. T. Greenland Davies' report under the Coal Mines Act, 1911, on the inspection of mines in the Northern Division during 1931. The division includes, in addition to the Northern coalfield, the counties of Cumberland and Westmorland, the North Riding of Yorkshire, the Furness district of Lancashire and the Isle of Man. The output of coal during the year was 44½ million tons, or 6¼ million tons less than in 1930, and the ironstone output from Cleveland and Westmorland also declined by 670,000 tons to 1½ million tons. The average number of persons employed in the mines fell from 195,000 to 170,000. Mr. Davies reports that progress is continuing in the transport of coal by conveyors, and he regards this as an important contributory factor to the decrease of underground haulage accidents reported during the year. Dealing with explosions of fire-damp or coal dust, the Inspector stresses the necessity for the maintenance of adequate ventilation and quotes a circular letter on the subject which he issued during the year. In connection with accidents from falls of roof and side, Mr. Davies indicates by sketches the heavy incidence of fatalities at gate ends, and emphasises the importance of providing systematic and adequate inspection.

Miscellanea.

NEW motor lifeboats are being built for the Walmer and Dungeness stations.

A FACTORY for weaving pure silk is to be put up at Paisley by a Viennese firm.

THE Clogau gold mines at Bontddu, near Barmouth, Wales, have been reopened

A TEXTILE Machinery Exhibition will be held at Leicester from October 7th to 15th, 1932.

THE Liverpool Gas Company proposes to acquire the gas undertaking of Huyton and Roby.

A NEW aircraft factory is to be put up at the Portsmouth Municipal Aerodrome by Airspeed, Ltd., of York.

THE number of farms in Canada using tractors for agricultural work has increased from 43,578 in 1921 to 97,176 in 1931.

IT is proposed to reclaim an area of 10,000 acres of rich alluvial land at Kootenay Flats, near Creston, British Columbia.

IT is reported that the Danish State Railway administration has decided to order no more steam locomotives and to use only those driven by oil engines.

A PULP and paper mill with a capacity of 12,000 tons a year, is to be put up at Fez, Morocco. It will use alfalfa, straw and dwarf palm as raw materials.

ON the completion of her last voyage the Canadian Pacific liner "Empress of Britain" had made eight Atlantic crossings in eight consecutive weeks.

THE French super-liner "Ile de France" (70,000 tons displacement) is to be launched at St. Nazaire on October 29th, and commissioned for service early in 1934.

THE Irak Petroleum Company is planning to export 4,000,000 tons of oil annually from the Irak oilfields as soon as the pipe line to the sea has been completed.

THE nitrogen fertiliser factory in Pét has recently started operating. It will supply the whole needs of Hungary in nitrogen fertilisers, sulphuric acid, and nitrate of ammonia, with a surplus available for export.

THE telephone service of Rhodesia has been extended to Kafue, and there is a full service from Livingstone, the capital of Northern Rhodesia. Extensions are also being made to other centres along the railway to the copper fields.

THE ship repairing yard of Clelands Ltd. at Willington Quay-on-Tyne has been purchased by a group of business men, mostly from the Humber district, and is to be continued at present. There are two vessels under repair at the yard.

IT is reported that during her recent trials the French flotilla leader "Cassard," built by the Chantiers de Bretagne, attained a speed of 43·4 knots on the measured mile and maintained an average speed of 42·9 knots for three hours.

IT is announced by the White Star Line that the departure of the British trade ship "Laurentic" for Canada, which was to have sailed from Liverpool on October 1st, has been postponed, but that she will probably sail in the spring of next year.

THE exports of radio receiving sets, loudspeakers, valves, and other cognate material from the United States during the five months ended with May last attained a value of £1,056,650, as compared with £1,633,545 in the corresponding period of last year.

THE fifth ship of this season left Churchill, Hudson's Bay, on September 9th, laden with grain, namely, the s.s. "Grelhed," for Cardiff with 264,000 bushels of wheat, bringing the total shipments thus far from the new port to over 1,000,000 bushels.

IT is expected that by the end of the present year most of Cape Town's telephones will be changed over from manual to automatic operation. Siemens Brothers, of Woolwich, are supplying the equipment, and some 20,000 telephones of the Neophone type.

THE Luft Hansa Company is arranging to moor the Norddeutscher Lloyd liner "Westfalen" off the coast of Brazil to act as a refuelling station for aeroplanes crossing the South Atlantic. She is to be provided with a landing state, fuel, spare parts, and wireless equipment.

IT is expected that water will be allowed in the new cofferdam at West Saint John, New Brunswick, by October 1st, marking the gradual completion of four years of new construction work on piers, elevator, &c. The elevator has a capacity of 1,500,000 bushels and can be increased to 3,000,000 bushels, if needed. The work includes two massive concrete piers with sheds, &c.

THE new Breslau transmitter in Rothsürben, which is about to begin its transmissions, has been equipped with a new type of aerial, the shape of which differs considerably from that of the usual aerial. According to *World-Radio*, it creates greater field intensities, and the nearest zone of fading occurs at a greater distance than before, which means that a larger area is served by the surface wave and is therefore free from fading.

ACCORDING to the *Montreal Star*, the reason why English anthracite is more popular than American coal in Canada is that it gives more heat and produces less ash. Shipments of Welsh and Scotch anthracite entering the port of Montreal amount for the season to date to 691,000 tons, compared with 471,000 tons for the same period of 1931. Imports of British bituminous coal are given at 104,000 tons, compared with 10,000 tons.

A "JUPITER," Series VII. F., supercharged engine, constructed by Messrs. Polskie Zaklady Skody, of Warsaw, to the order of the Polish Government, who hold a licence for the manufacture of "Bristol" type aero engines in Poland, has recently completed a successful type test of 100 hours. The total running time during the eight days occupied by the test was 115 hours 35 miputes, comprising some 40 hours on the Froude dynamometer and 73½ hours on a calibrated airscrew, the balance being occupied by preliminary runs for warming-up purposes.

BARKING-UPMINSTER RAILWAY ELECTRIFICATION

(*For description see page* 310).

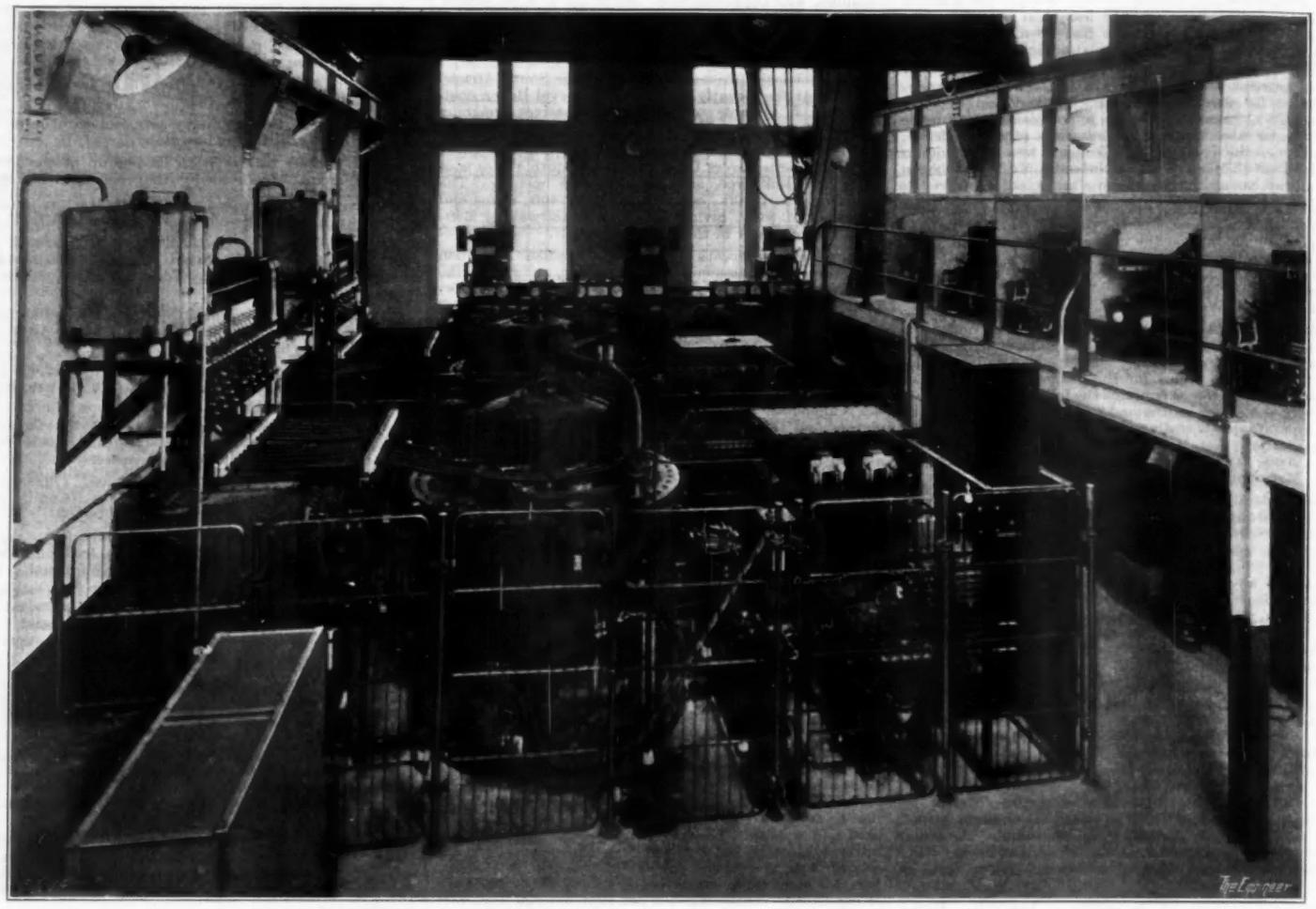


FIG. 9—GENERAL VIEW OF UPNEY RECTIFIER SUB-STATION

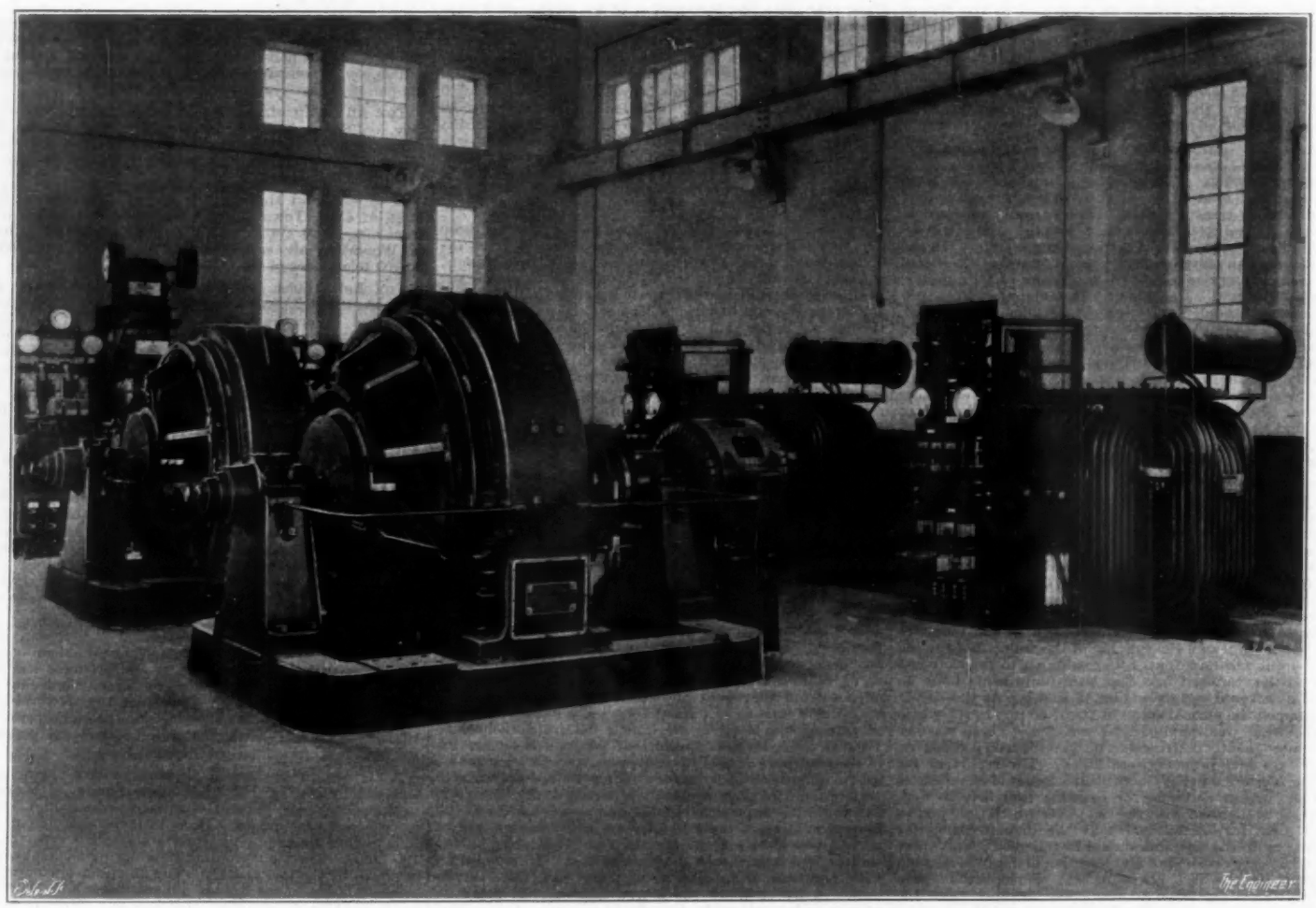


FIG. 10—GENERAL VIEW OF HEATHWAY ROTARY CONVERTER SUB-STATION

The Engineer

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NOTICES TO READERS.

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THE MECHANICAL ENGINEERS' CANADIAN VISIT.

IT is no secret that, at one time, grave doubts were expressed concerning the wisdom of proceeding with the arrangements for the proposed summer meeting of the Institution of Mechanical Engineers in Canada and the United States. It was argued that the depressed state of industry on both sides of the Atlantic would conspire against success, that an insufficient and non-representative selection of the members would find it possible to undertake the trip, and that our Canadian brothers and American cousins would be compelled to modify the cordiality of their welcome to us. These and other dismal predictions have been completely falsified. From every angle the visit was a successful one, and fully repaid all who took part in it and those who had the courage to persist with its organisation. Socially it was a delightful experience. Technically it scarcely suffered from the undoubted and undisguised depression which prevails in Canada and the United States. From the Imperial and international standpoint it sowed many seeds of harmony, good will and understanding, and provided a fitting and valuable corollary to the work of the recent Empire Conference at Ottawa. Boldly conceived and efficiently carried out, the Institution's summer meeting of 1932 resulted in the establishment of numerous personal and business contacts from which much good cannot fail to flow. To many of those from this side it was an education in Canadian and American life and ways. To not a few friends on the other side it no doubt afforded proof that the British nation is not down and out, that we are still ready to laugh at our troubles and to seek with vigour opportunities for developing trade.

Under the fatherly charge of the President, Mr. William Taylor, a happy family, numbering some 114, left Southampton at 1 p.m. on Friday, August 19th, in the Canadian Pacific liner "Montrose." Of that number just on one-third were of the gentler sex, and it may here be placed on record that the ladies, graciously headed by Mrs. Taylor, played a vital part in the success of the trip, not only during the days spent at sea, but throughout the fortnight's tour in Canadian and American territory. More so than the male members of the party, the ladies had opportunities afforded them of acting, in divers ways, as apostles of the Empire, and, fatigued though they were at times, they never failed to discharge their important duty with charm and tact. The Atlantic was exceptionally kind on the outward voyage, although it would be unfair not to credit the excellent sea-going qualities of the "Montrose" with a considerable share in the factors which promoted general comfort. Off the Straits of Belle Isle two icebergs gave the visitors a chilly reception to the New World, and inside a gale awaited them. Later, between Quebec and Montreal, a sudden, fierce squall of wind, rain and vivid lightning provided another illustration of the St. Lawrence's uncertain character. Quebec was reached twelve hours ahead of time at about 6 p.m. on Friday, August 26th, and following a hurried tour round the historic city the next morning the party returned to the ship and resumed the journey up the St. Lawrence. At Montreal on the morning of Sunday, August 28th, the visitors said good-bye to the "Montrose," and began what was to prove a strenuous fortnight of travels by land. Merely to name the different places of interest visited by the members of the party in groups or as a whole would occupy more space than is at present at our disposal. For the time being it must suffice to say that from Montreal the party passed on to Ottawa, Toronto, Hamilton, Brantford and Niagara Falls. For two full days and three nights it lingered at the Falls and recovered some of the energy which had been dissipated since landing. The great natural spectacle, although cheapened and vulgarised after dark by coloured flood-lighting, disappointed only a few, and on the morning of Tuesday, September 6th, it was with more than regret that the visitors crossed the International Peace Bridge and turned their backs on the Falls. However, they were now in the United States, and for the next four days were to be left little time for vain musings. By rail they were taken first to Rochester and then on to Schenectady, and finally to Poughkeepsie, where the river steamboat "De Witt Clinton" was boarded for a 70-mile trip down the Hudson to New York. Of the two days spent in that city we ourselves still do not feel that we can write coherently. We might say something of how four omnibus-loads of the members lost their way in the wilds of Hoboken searching for the Stevens Institute of Technology. We could easily, we feel, become lyrical were we to concentrate on the view to be obtained from the 102nd storey of the Empire State Building For the time being, however, our impressions are still dominated by a mad dash at 40 miles an hour without a stop through the very heart of New York at the tail of a "speed-cop," complete with revolver, cartridge belt and syren, who cleared the road for the visitors as if they were royalty, the fire brigade, a victorious base-ball team, or a returning Transatlantic flyer. Until the passage of time places that ride in its proper perspective, we feel it would be unsafe for us to express any views, appreciative or otherwise, about New York. We will permit ourselves only to say that it was with a sense of relief that at midnight on Friday, September 9th, we found ourselves on the Cunard liner "Samaria,' slipping out past the Statue of Liberty bound for home. Some seventy-six of the original party were still with us. The others remained behind to visit privately additional works and places of interest in Canada and the United States. During the first two days of the return voyage the "Samaria" kept company with the tail end of a gale, but subsequently the sea moderated. Off the mouth of the Channel a heavy fog was encountered, and in eerie circumstances we nosed our way into Plymouth Sound shortly after midnight on Saturday, September 17th. Having discharged a few of our company at that port, we at once proceeded to sea for Le Havre and London. The tour came to an end at 8 a.m. on Monday, September 19th, at which hour we disembarked all safe and sound at the King George V. dock on the Thames.

A sojourn of ten days on Canadian soil and of four days in the United States is obviously insufficient to enable anyone to form a sound impression of the life and activities of either country. Even although the visit had been less hurried than it was, it would still have afforded a very partial glimpse of conditions on the North American Continent by virtue of the fact that the itinerary was confined to two provinces in Canada, and to one state in the United States. It would be as foolish to regard what we saw and heard as being typical of social and industrial life in North America as to think of the Empire State and Chrysler buildings as being typical of the architecture of Greater New York. In one direction only do we feel that our experiences during the trip entitle us to venture a broad opinion. In this country, it is to be feared, many of us take the Empire very much for granted. In Canada, outside the large, and still intense, French section of the population, the Imperial connection is very highly regarded. As a sentiment it is constantly present in the minds of the bulk of the people, alike whether they are native-born or are immigrants from our own islands. The propinquity of the Dominion to the United States, the similarity of natural conditions, and the necessity for adopting, in many important directions, the same manufacturing and commercial standards, have, almost inevitably, drawn Canada's industries into close association with those on the other side of "the line." But, unless we were totally misled—and we studied the point from many angles—no one regrets the enforced American connection more than the Canadians themselves, and no one is better pleased than they when it becomes possible to overcome the natural and artificial barriers which lie in the way of closer trade relations between the Dominion and the land which they are still proud to call "The Old Country." The Ottawa Conference may ultimately result in effecting improved economic relationships between us and our Canadian brothers. The difficulties are undoubtedly great, but on the Canadian side, at least, we are certain that failure will not come because of any lack among the general population of a true and generous affection for the Empire. It is our pleasure to think that no small contribution towards the desired success of our political leaders' aims was made by the friendships and understandings established during the Institution's visit to Canada.

Science and Invention.

IN the current number of the *Journal of Scientific Instruments* may be found a special article by Dr. Harry Moore on "The Potential Value in Industry of Discoveries which are of Comparatively Small Scientific Importance." The thoughts which are raised by this suggestive essay begin with the title itself. How can one speak of any discovery as of "small scientific importance"? History is full of discoveries of which the "scientific importance" was not recognised at the time. Indeed, one might almost go so far as to say that the great natural philosophers are those who have correlated numerous "unconsidered trifles" and made scientific generalisations from them. Hence Dr. Moore is obliged to present a criterion of "importance." It is "the extent to which the trend of scientific thought in general, or in any particular branch of science, has been influenced by the discovery under consideration," and he offers as an example:—"The discovery of the polarisation of light will be considered to rank as a discovery of major importance, while the establishment of the fact that copper is a better conductor of heat than lead or iron will rank definitely as of minor importance." By such a rather empirical division does not Dr. Moore seem to imply that the method of propagation of light is of greater "scientific importance" than the method of propagation of heat? It is, we suggest, not justifiable to assume that the observation that copper stands higher in the table of conductivities than iron or lead is of small scientific importance, or even of less scientific importance than the fact that a beam of light may be polarised by a Nicols prism. There is a relationship between heat conductivity and electrical conductivity, but we assume, perhaps incorrectly, that Dr. Moore would not regard the recent remarkable demonstration of the disappearance of the electrical resistance of metals at extremely low temperatures as of small scientific importance.

With this caveat as to the undesirableness of drawing a line between important and relatively unimportant discoveries we may pass on to other considerations raised by Dr. Moore's article. Its purpose, he says, is not "to consider the possible industrial applications of what may be regarded as fundamentally important scientific discoveries, but is rather to draw attention to the potential industrial value of comparatively unimportant scientific discoveries. . . . There are many discoveries which, while being in no sense fundamentally important from the scientific standpoint, have proved to be of far-reaching importance in their industrial applications." He gives several

examples, and to them we venture to add as peculiarly striking Roget's discovery of the persistence of vision which step by step has led up to the film industry, and the Fleming thermionic valve, which is at the root of the wireless industry. When the magnitude of those two industries is remembered the truth of Dr. Moore's observation is obvious. He further remarks that "The extent to which scientific discoveries, whether of major or minor importance, can be utilised in fostering or creating industrial developments depends, however, in a large measure, on how far industrial needs are made known to the scientist. . . . More might be done, perhaps, if manufacturers were encouraged not to limit their enquiries to matters related to processes or to projects which they recognise as being essentially practicable, but to put forward, for discussion, ideas of what they consider would be desirable in their own particular branch of industry, even though they have little hope of the desired result being achieved." Whilst there are many cases in which the scientist has been able to assist industry in the manner indicated in this sentence, it must be admitted that, in general, industry lacks the imagination which alone can inspire problems to put before scientists; and that, when it has the imagination, it is hampered by the knowledge it already possesses. Hence it would seem that much is to be expected from the stimulation of industrial imagination by scientific, or quasi-scientific, discoveries, for the manufacturer who is unable to advance any suggestions for research may be quick to see the possibility of applying a new discovery or invention to his own purposes. A brilliant example is presented by the dynamo. We cannot suppose that any inventor of his day would have been blessed with sufficient imagination to ask Faraday to seek for a means of generating the magneto-electric current, but once Faraday had shown the way numerous inventors had imagination enough to see how the principle of induction might be usefully applied. This instance, amongst many, is frequently advanced in support of research "into the blue"—research without a definite industrial object. The imagination that is insufficient to inspire a novel research may be sufficient to make use of discoveries which it has not inspired. It is the inventor who has the watchful eye, who is not so concentrated on his own work that he cannot see beyond it, and is not hampered by the restrictions which it seems to impose, who is most likely to turn to useful purpose discoveries whether they be of great or "small scientific importance."

But if the industrial inventor is sometimes to blame for failing to present problems to the scientist, the scientist himself cannot always escape criticism. He also may be a man of little imagination and may be too ready to dismiss suggestions as impracticable dreams. "In discussing any project put forward," says Dr. Moore, "the scientist should not be too didactic in saying what is or is not possible." He offers, in support, the well-known case of the Giffard injector, which appears to defy the elementary truth that steam from a boiler cannot be made to force water through a loaded valve into the same boiler. The self-excited dynamo is a parallel instance. The scientist is a person who is intimately acquainted with natural laws, and it sometimes happens that his imagination is as much circumscribed by those laws as the imagination of the industrialist is circumscribed by the conditions under which manufactures are carried on. We know only too well the consequences that beset the too-open mind—how many are the perpetual-motionists who have left our doors with the advice to test it by experiment!—yet we must agree with Dr. Moore that, save in things outside all reason, the scientist must not be over-ready to say what can and what cannot be done. Is not all scientific progress the realisation of the incredible?

Literature.

The Scientific Principles of Petroleum Technology. By Dr. LEO. GURWITSCH and HAROLD MOORE, M.Sc. Tech., M.I. Petrol Tech., F.C.S. London: Chapman and Hall, Ltd. 30s.

THIS book is essentially one for the petroleum chemist, and its scope is so wide and the data presented so comprehensive that it is unlikely that he will discover any aspect of the subject untreated or treated inefficiently. In the authoritative and reliable hands of Mr. Harold Moore one would have expected no less.

Should the reader desire to study more exhaustively some special aspect, the numerous references given will enable him to do so. Furthermore, certain aspects of the subject inadequately dealt with in the previous edition of this work receive proper attention in this, the second edition. To omit reference to the latest American developments would be to write "Hamlet" without the Prince of Denmark, for America is not only the cradle of the oil industry, but her petroleum technologists have led the way in adapting every branch of the industry to modern commercial and economic requirements. American work now occupies its proper relative position in the volume.

The book is, indeed, an encyclopædic record of every investigation and experiment carried out by the petroleum chemists of any note throughout the world. Its main divisions are raw material, covering chemistry and physics, brief characteristics of the most important petroleum oils and origin of petroleum; manufacture, covering preliminary treatments, refining and products.

Because the work is largely based on a multitude of authorities, it is difficult to review it in a restricted space. There are so many aspects which might be referred to, all of interest to the petroleum chemist. The presence of sulphur, for instance, has always been a source of difficulty in the treatment of crude oils. On this subject the author remarks that the action of sulphur on hydrocarbons is as yet insufficiently investigated, and "the multiplicity of sulphur compounds to be found in petroleum makes it likely that the desulphurising is carried to different extents in the different cases of ordinary refining." He then gives the results of investigations made on this element, and on the action of sulphuric acid on distillates, and shows how practice differs in relation to the composition of the oil. Comprehensive tables of the sulphur content of crude oils found on the American continent are given, followed by data regarding crude oils from other fields, which, in turn, is succeeded by a bibliography indicating how wide the research has been into this aspect of the subject.

A section which will be of interest to the modern petroleum chemist is that dealing with the use and influence of catalysts, an aspect of distillation recently developed in the treatment of low-temperature tar oils. The Bergius process is also dealt with in this edition of the work, restricted, of course, to petroleum, and not extending to coal, in which connection the name of this scientist is best known. Bergius has recently devoted his attention to a high-pressure process for the cracking of petroleum products as a development of his original idea. Mr. Moore remarks that this process is of extreme interest, as denoting the possible tendency of future developments in the cracking process, and it is evident from the data given that the subject is not yet thoroughly understood.

Other aspects of interest, apart from the vast amount of data on general petroleum technology, are the particulars given relative to insulating oils and their characteristics and behaviour under different conditions, the pages devoted to motor spirit and its characteristics and behaviour in an engine, and the introduction of what is termed the Tube still. This still differs from the old type of still in that the heat is provided from fuel burnt inside a tube, the gases passing round the outside of the still, thus making more heating surface available and resulting in higher efficiency, a considerable conservation of heat, and other advantages to which the author refers. A sectional view of this still is presented, together with viscosity temperature curves, and other illustrations, diagrams, and tables.

SHORT NOTICES.

Reinforced Concrete Designers' Handbook. By Chas. E. Reynolds, B.Sc. London: Concrete Publications, Ltd., 20, Dartmouth-street, S.W.1. Price 15s. net.—The object of the author in writing this book was to provide an up-to-date reference book for designers and to simplify practical reinforced concrete design in general. Part I. deals with the following subjects:—Loads; Horizontal Pressures; Bending Moments and Shearing Forces; Framed Structures; Foundations; Retaining Walls and Containers; Bridges, Buildings, &c.; Concrete Materials, Mixes, and Stresses; Reinforcement; Beams and Slabs; Shear Resistance; Columns; Combined Stresses; Specifications, Quantities, and Cost Estimating. In Part II. tables to cover all classes of reinforced concrete structures are given, and the large number of explanatory examples showing how the tables are used greatly enhance their value. The third part is a classified descriptive bibliography—a useful innovation in a work of this kind. There are many books on reinforced concrete design, but we feel sure that this new volume will be found of definite value to all connected with this class of work.

BOOKS RECEIVED.

Der Stahlhochbau. By C. Kerston. Berlin: Wilhelm Ernst and Sohn, Wilhelmstrasse 90, W.8. Price 18 marks net.

The Electrical Age. By V. H. L. Searle, M.Sc. London: Ernest Benn, Ltd., 154, Fleet-street, E.C.4. Price 10s. 6d. net.

Modern Materials Handling. By S. J. Koshkin. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 37s. 6d. net.

Architectural Acoustics. By V. O. Knudsen, Ph.D. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 40s. net.

Sewerage and Sewage Treatment. Fourth Edition. By H. E. Babbitt. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 31s. net.

Iron and Steel Institute and Institute of Metals.

No. I.

THE first business session of the joint autumn meeting of the Iron and Steel Institute and the Institute of Metals, in London, was held on Tuesday morning, September 13th, in the lecture theatre of the Institution of Civil Engineers, Great George-street, Westminster, when papers of interest to members of both bodies were read and discussed. Subsequent sessions were held by the two bodies separately, but the members joined together again on the occasions of works visits and social functions later in the week. Colonel Sir W. Charles Wright (President of the Iron and Steel Institute) was in the chair at the opening of the first session, and Sir Henry Fowler (President of the Institute of Metals) was beside him. During the remainder of the session, Sir Charles presided when papers by the Institute of Metals were presented, and Sir Henry presided during the reading and discussion of papers by the Iron and Steel Institute. This friendly gesture of "exchanging" Presidents was much appreciated.

Sir Charles Wright, after extending a welcome to the President and members of the Institute of Metals, explained that, by the kind invitation of the American Iron and Steel Institute and the American Institute of Mining and Metallurgical Engineers and its non-ferrous division, arrangements had been initiated for holding the meetings of the two British bodies this season in America, but circumstances had proved too strong and it had been found necessary to abandon such plans. He joined with Sir Henry Fowler in expressing gratitude to their American friends for their invitation, and added that they might yet witness the fulfilment of the original plan in the not very far distant future. The Councils of the two British bodies, however, had maintained the idea of holding simultaneous meetings, and that was a source of real pleasure to him, especially as Sir Henry Fowler, the President of the Institute of Metals, was a very old friend of his, and many metallurgists were members of both bodies.

Sir Henry Fowler, on behalf of the Institute of Metals, also briefly expressed appreciation of this opportunity for the members of both bodies to meet together.

THE MANUFACTURE OF NICKEL AND NICKEL ALLOYS. (*Inst. Met.*)

The first paper presented was by W. R. Barclay, G. A. V. Russell and H. Williamson, on "Modern Works Plant and Equipment for the Hot Working of Nickel and Nickel Alloys." There was one alteration to the statements in the paper with regard to control of the ingots. The paper stated that these were controlled manually, but that had been altered, a simple manipulator having been designed by a member of the works staff by which the ingots were withdrawn mechanically.

This paper describes a modern plant erected in Great Britain as a result of experience in the hot-working of nickel and its alloys and a close study of the conditions under which similar work is carried out on the Continent of Europe and in America.

The main features of the plant are:—

(1) Hydraulic forging press;

(2) Hot-rolling mill, consisting of—(*a*) a universal-type mill with horizontal and vertical rolls for the production of sheet-bar and strip; (*b*) a three-high Lauth-type mill for the rolling of sheet-bar and small rectangular ingots into sheets.

A detailed description of each section is given with diagrams and illustrations.

Various prevailing methods of practice in other countries are compared and underlying principles discussed.

The test includes an outline of the methods of production adopted in working the plant.

The heating of sheet-bar for rolling into sheets is carried out in a specially designed electric resistance furnace, which is described and illustrated.

The paper concludes with some general remarks on the hot-working of nickel and its alloys.

Dr. W. J. P. Rohn (of Germany), who expressed appreciation of the valuable development work carried out by the authors and congratulated them upon it, said it showed the kind of development that might be expected in the future with regard to non-ferrous metals.

Dr. W. H. Hatfield said that the iron and steel industries were not very much interested in "precious" metals, by which he meant that they could really take a far greater interest in the metallurgy of nickel if its economic value were such that its use was really permissible on an extensive scale. The authors said that it was necessary to plane the surfaces of the nickel ingots, and that was probably one reason why that metal was on rather an uneconomic level; but it would be interesting if they would explain technically what the difficulties were in these surfaces which necessitated machining operations. Was it cold lapping or trapped slag, or was it a case of occluded gases being given off under subcutaneous blow-holes? Again, he pointed to the emphasis laid on the desirability of keeping the nickel ingots away from sulphurous gases. He believed that to be necessary, but it was found in ferrous metallurgy that one could add 10, 12, 15 or 20 per cent. of nickel and produce alloys which appeared to be immune from the action of sulphurous gases.

Mr. Barclay, replying to Dr. Hatfield's question as to the reasons for planing the surfaces of ingots, said it was possible to produce quite respectable-

looking material without planing at all, but it happened that the trade required an extraordinarily high standard of finished sheets, and one of the difficulties, particularly with pure nickel and very rich nickel alloys, was that magnesium was used as a de-sulphurising and de-oxidising agent, and under those circumstances there was great difficulty in securing perfectly clean ingots. The metal poured, as the casters would say, "more like treacle than water." As to sulphur, he agreed that when nickel was present to the extent of only 10 or 12 per cent., the sulphur problem was by no means so serious as in the case of rich-nickel alloys; the plant described was dealing with pure nickel and with alloys of from 70 to 90 per cent. nickel content, and in that class of material the problem of sulphur was serious.

I.C. ENGINE VALVES. (*I. and S. Inst.*)

The next paper was entitled "Metallurgical Problems Connected with Internal Combustion Engine Valves," and was presented by Mr. J. R. Handforth.

In this paper the author remarks that the requirements for valve steels are so numerous and varied in character that it has not yet been possible to find any one steel which will fulfil the whole of them.

Modern valve steels successfully meet the need of great strength and high notched-bar value at working temperatures, and the other requirements concerning freedom from forging cracks, heat treatment without residual strains, and capacity to be hardened at the ends of the stems, now offer little or no difficulty.

The troubles which formerly arose through the scaling of valves have been almost entirely eliminated. This difficulty has been reopened by the increasing use of fuels containing tetra-ethyl lead, or Ethyl Fluid, of which the products of combustion are more corrosive than those of ordinary fuels. Much research is at present being undertaken to solve this difficulty. The austenitic valves with a high nickel content appear to be most resistant to corrosion of this type, and distinct improvement has been obtained by reducing the working temperatures of the valves.

The failure of valves by cracking round the seats may be caused by defective forgings with residues of cracks round the peripheries, unsatisfactory macrostructures of the valve heads, intercrystalline brittleness of the valve steel due to the deposition of carbides, or to the penetration of oxygen into fissures arising from irregular distortion of the face of the seat of the valve.

Short-time hot tensile tests on an austenitic valve steel to specification D.T.D. 49 show, under certain conditions, an unexpected lack of ductility. It has been demonstrated that when such steels are distorted at low temperatures the residues of massive carbides remaining from the original ingot structure do not flow at the same rate as the austenitic matrix. It is suggested that this difference in the rate of flow may be the starting point of cracks, both during forging and during the service of valves.

Efforts have been made to increase the service obtained from valves by welding stellite on to their seats. By this means the seats are rendered exceedingly hard, both at normal and at working temperatures. This appears to eliminate entirely the wear and distortion which occur under normal running conditions. The application of stellite by welding gives rise to interesting metallurgical problems. Silchrome valves were successfully treated in this manner, but the stellite applied to cobalt-chromium steel valves invariably cracked. When austenitic valves were so treated, exceedingly coarse structures were sometimes produced owing to the poor heat conductivity of these steels. Such coarse structures cannot be removed by heat treatment.

Professor J. H. Andrew said that many of the so-called austenitic steels might be austenitic immediately after they were made, but he was inclined to think, after looking at some of the photographs in the paper, that some of those steels, after annealing at a high temperature for 1000 hours, showed a tendency to become martensitic, and hardened. The author treated the steels he had dealt with at a constant temperature for 1000 hours, but, presumably, it was not suggested that that was the same treatment as a valve would be subject to in an automobile engine where there were variations of temperature. He made this point for the reason that under variations of temperature a steel would tend to change to martensitic steel and there was the possibility of changes at high temperatures and low temperatures, such as would be experienced in normal working in an automobile engine.

Dr. W. H. Hatfield said it should be realised that the author's treatment of the steel for 1000 hours was equivalent to from 100,000 to 200,000 miles flying, which was a terrific demand to make on those steels. The difficulty which investigators into that problem were faced with was that of actually visualising the conditions under which the valve would work in service. The silicon-chrome steel gave excellent resistance to oxidation, but it had comparatively little strength, but, as the author had said, its high critical range was of very great advantage, because the allotropic change was not encountered within the life of the valve. That steel had been and was being used in large quantities, and yet it was utterly different in characteristics to the nickel-chrome-tungsten steel. At the same time he did not see the need for adding 30 per cent. nickel, speaking, of course, on purely scientific grounds, when 10 to 12 per cent. nickel would be quite sufficient to meet the conditions the author had in mind.

Colonel N. Belaiew repeated a suggestion he made to the Institution of Automobile Engineers some years ago that suitable micro-structures, best suited for different types of valves, should be evolved and published. That would give the steel makers something to work upon.

Mr. T. H. Turner said that some years ago he examined some American aero valves in which the structure was austenitic at the head and martensitic in the stem. When he first received the author's paper, he looked up these samples and was surprised to find that the austenitic head had gone rusty, whilst the martensitic stem was quite all right. In those valves there was a difference in structure at the root of the head, and it would be interesting if the author could say if there had been trouble from valves breaking where the austenitic and the martensitic structures joined. It occurred to him that the type of cast iron, known as Nicrosilal, or the newer types of cast iron, used in conjunction with a steel stem—if cast in correct shape—might give really good service.

Dr. J. W. Jenkin, referring to the statement in the paper that silicon, particularly in the presence of chromium, produces wonderful resistance to oxidation, said that fact was noted some 2½ years ago by Messrs. Page and Partridge, in a paper before the Iron and Steel Institute, when it was also pointed out that silicon-chrome valve steels were not suitable for very complicated forgings. It occurred to him that if the carbon content could be reduced, those steels might be made suitable for more complicated work. Since then experiments had been carried out in the manufacture of more complicated parts, and, indeed, the steel manufacturers had been manufacturing steel tubes with those steels. That opened up a very wide field, particularly as the resistance to oxidation made such steels suitable for heat exchange parts, such as superheater tubes and oil cracking apparatus. From that point of view, therefore, it seemed to him that the silicon-chrome steels of low carbon content had a considerable future.

Sir Henry Fowler (President, Institute of Metals), in proposing a vote of thanks to the author for his paper, said it had been intensely interesting to him because during the war he had had so much to do with aeronautical engines. Although in those days it was felt that a great deal had been done, it was obvious that considerable advance had been made since, but it was the use of a 13 per cent. chromium steel at that time which gave the hope that the advances would be made, which, from the paper, apparently had been made. With regard to the suggestion by Colonel Belaiew that there should be a standard micro-structure, the only thing that he had ever dared to put into a specification was what the micro-structure should not be, but he hoped the point raised in that connection would receive attention at the hands of scientific men.

Mr. Handforth promised to reply in writing.

MOULD MATERIALS FOR NON-FERROUS STRIP INGOTS. (*Inst. Met.*)

In this paper, the author, Mr. G. L. Bailey, says:

Grey cast iron is the material most generally used for moulds for the casting of non-ferrous strip ingots. Cast iron moulds are subject to two particular defects:—(*a*) Gas evolution from the face of the mould when this is overheated during pouring ("blowing"); (*b*) transverse cracking of the working faces. The conditions producing "blowing" have been studied and the gas has been found to originate in a reaction between the carbon of the iron and a superficial oxide film.

Transverse cracking of the cast iron mould surface is due to stresses resulting from a high temperature gradient in the mould wall immediately after casting. Mild steel moulds, which are free from "blowing" and cracking, are liable to serious distortion resulting from such stresses.

Copper is considered the most satisfactory material for strip ingot moulds. Its high thermal conductivity prevents serious temperature gradients and consequent distortion. For high melting-point materials, copper moulds are, with advantage water cooled, but for alloys, such as brass, they can be used under certain conditions without any special cooling.

Dr. W. Rosenhain, who regarded the results described as being likely to prove of practical importance, said that perhaps the most interesting feature of Mr. Bailey's results was his explanation of the warping of, say, ordinary steel moulds, and the non-warping of cast iron owing to internal cracking. It sounded all right; indeed, it was almost too easy to believe that that was really the whole story. If it were the whole story, it seemed that there were mechanical ways of overcoming the trouble. For instance, one might make a number of saw cuts on the inside of a steel plate to be used for a mould, or in some other way rob the inner face of tensile strength. Then, surely, it would have to behave exactly like a cast iron mould cracked on the inside, and would not warp more. It would be feasible to fill the cracks with perhaps copper, or provisionally with some dressing which would not cause trouble in the metal, and in that way one could use a steel plate. There would be advantages if that could be used. With regard to the "blowing" phenomenon, and the suggestion—probably sound—that it was due to the reaction between an oxide film on the molten metal entering the mould, and the carbon of the mould itself, it seemed that there were two ways of overcoming it. One, which he believed Mr. Bailey and his friends had attempted, was to prevent oxidation and the formation of the oxide film. The other was to remove the carbon from the surface of the mould, *i.e.*, to use a material, the surface of which had been de-carburised, as by suitable annealing.

Dr. R. S. Hutton said that the work described was initiated at the very special desire of the Brass Ingot Casting Section of the British Non-Ferrous Research Association, and it indicated that the non-ferrous metals industry was tackling its problems very seriously. It was important that those utilising copper for mould purposes should realise the importance of using the best high-thermal-conductivity copper for the purpose. The conductivity of egineering copper, was only about 50 per cent. of that of high-conductivity copper.

Dr. W. J. P. Rohn (of Germany) recalled some experiments carried out some years ago, in which saw cuts were made on the inner surface of steel moulds, and said that when the cuts were very close together a certain amount of success was achieved. But, as Dr. Rosenhain had pointed out, the saw cuts must be filled with some material to prevent the liquid metal entering them, and if they were filled with a non-metallic material it led to the development of blowing; even if the cuts were filled with metallic strips, there were usually small spaces left into which air could enter, and very often they became filled with dirt, which also led to blowing. In his experience, therefore, that seemed to be an unsuitable method for improving steel moulds. An ingot mould made of pure copper was fairly expensive, but one could use a very thin-walled copper tube for a mould if it were surrounded with steel or cast iron, and provided with guides for leading the cooling water. In his experiments it had been found suitable to have a wall thickness of about ¼in., and the initial outlay was less than for a grey iron mould. Even for materials such as nickel and steel, one copper lining would stand more than 3000 or 4000 castings, and its replacement cost only a few shillings. If the outer part were made of steel or cast iron, the mould was very strong.

Mr. A. J. G. Smout was particularly interested in the author's conclusion that copper was considered to be the most suitable material for moulds for non-ferrous strip ingot casting, and said that modern works practice was definitely turning in that direction. He personally believed the iron mould to be as obsolete as the old stone mould of the eighteenth century. His company was banking on copper moulds, and was casting over 500 tons per week in them. Copper refiners twenty-five years ago were beginning to realise the advantages of the high thermal conductivity of copper, and were casting their copper cakes on copper bottoms, and to-day they were more and more extensively casting copper on copper bottoms and in copper moulds. It had taken the brass strip casters a considerable time to take a leaf out of the copper refiners' book, and it was not until about eight years ago that they in this country began to experiment with copper moulds for brass strip casting. The cast iron mould was too soft for practical purposes, although he admitted that, because they were strongly in favour of copper, perhaps they had not tried cast iron as thoroughly as they might otherwise have done. Distortion troubles had been overcome entirely by proper mould design. He urged that the copper used should be capable of being welded, for he had patched up moulds and increased their life considerably by welding.

Mr. W. R. Barclay said that his experience of casting nickel alloys in copper moulds was extremely encouraging. One of the real difficulties with the ordinary hematite iron mould was that the blowing effects were even more pronounced when the mould was new than when it was slightly worn, and some years ago he had studied carefully the behaviour of the copper mould, particularly in the casting of ordinary German silver alloys up to 25 or 30 per cent. nickel content. With the ordinary cast iron mould an enormous number, relatively, of surface cracks developed during the first day's work, sometimes in such number and size that the mould was rendered useless. He had tried taking the moulds out of service at frequent intervals and putting them under a simple milling pattern grinding machine fitted with a carborundum tool, to get the surface as smooth as possible, then putting the moulds back into service and taking them out again alternately. That practice had lengthened the lives of the moulds, but it was by no means so successful as water-cooled moulds. The latter were used not only for casting brass and German silver, but in one works they were used regularly for casting pure nickel, which involved a temperature in the region of 1550 deg. to 1600 deg. Cent. He agreed with Dr. Rohn that the water-cooled copper mould was definitely cheaper than the ordinary cast iron mould when consideration was given to the enormously enhanced life.

Dr. J. C. Hudson, discussing temperature gradient, said the author's curves relating to 0·1 per cent. carbon steel and cast iron showed very low thermal conductivity, and he was not sure that they represented the best results that could be obtained in that respect from ferrous materials.

Mr. Bailey, who intimated that he would reply to the discussion by means of a written contribution, said that the work described in the paper was not the last word; indeed, it was more or less an introduction to the study of the ingot mould question, and he regretted that he saw no immediate possibility of going further with it personally. Commenting on the remarks made concerning the use of high-conductivity copper in order to get the best results, he said that the 2ft. mould referred to in the paper, in which 70 lb. ingots were made, was built of rolled plates of electrolytic copper, and he considered that some such construction or a copper of at least 90–95 per cent. conductivity, should be used to get the best results.

NICKEL-CHROMIUM SILICON CAST IRONS. (*I. and S. Inst.*)

The next paper was on "Nickel-chromium-Silicon Cast Irons," and was presented by Messrs. A. L. Norbury and E. Morgan.

The chief result of the present investigation has been the development of a grey cast iron (Nicrosilal) containing about

18 per cent. of nickel, 6 per cent. of silicon, 2 per cent. of chromium, 1·8 per cent. of total carbon, and 1 per cent. of manganese, which is exceptionally resistant to growth and scaling, and is also remarkably ductile. In consequence, it is not liable to the cracking on sudden heating or cooling, which was the defect, for certain purposes, of the 4 to 10 per cent. silicon (Silal) cast irons from which it was developed. It is similar, in certain respects, to "Ni-resist," a low-silicon, austenitic, corrosion- and heat-resisting cast iron, containing nickel, chromium, and copper, recently developed in America.* The chief difference lies in the higher silicon content of Nicrosilal. The iron can be melted in the cupola, and there is no difficulty in obtaining total carbon contents as low as 1·8 per cent. or less from such melts, since the 4·3 per cent. eutectic carbon content of pure iron is reduced by the presence of 6 per cent. of silicon and 20 per cent. of nickel to about 2·0 per cent. of carbon. The iron solidifies at about the same temperatures as low-phosphorus, high-quality grey iron, but requires somewhat more feeding since its graphite content is lower. It can be run into sections less than ¼in. thick, and such sections can be cast free from white or mottled iron. It is easily machinable, giving a fine surface finish, and can be burnished and surface-hardened by cold-work. It is non-magnetic, has an electrical resistivity of about 160 microhms per cm. cube, and has good corrosion-resisting properties, which are improved by the addition of copper as in the case of "Ni-resist."

The composition may be varied over certain ranges, depending on the following factors. The above compositions have been made the subject of patent applications by the British Cast Iron Research Association and are being made, under licence, by members, for such purposes as furnace parts, moulds for glass and for metals, pots for case-hardening and for molten salts, internal combustion engine parts, &c.

HOT DIPPING.

The final paper read at the Joint Meeting on Tuesday morning was on "Some Reactions Occurring in 'Hot-dipping' Processes," by E. J. Daniels.

The part played by fluxes has been investigated and a general agreement found with diverse processes. The contamination of the liquid metal—"drossing"—is shown to be an inevitable factor in hot-dipping, soldering, &c., and methods for controlling it are indicated.

The coating of steel with cadmium and lead by hot-dipping is shown to be accompanied by the formation of the compounds FeCd, and $FePb_n$, which act as insulating layers preventing further attack. These compounds rise to the surface of the liquid bath, have high melting points, and are magnetic.

The action of molten tin on 8 per cent. "aluminium-bronze" is shown to be anomalous.

Dr. R. S. Hutton said that in addition to the work described by Mr. Daniels, experiments were being carried out at Cambridge. Galvanised coatings and their behaviour on tanks, tubes, and other products were being tested in connection with hot water corrosion. All that work was of very great practical importance. The author had gone a great deal farther into the question than might appear at first sight, because the whole field of soldering and jointing of metals was more or less directly touched upon by the conclusions given. Any new knowledge that could be gained or any new facts that could be secured on the mechanism of fluxing in connection with soldering and brazing was likely to be extremely important both to the scientific worker and particularly to the practical craftsman.

Mr. G. K. Rylands expressed the view that the author seemed to be rather pessimistic with regard to the coating of metals when he stated that the production of dross was inevitable. Personally, he questioned that, because he believed that if suitable precautions were taken and the process was brought under better control, the amount of dross produced in wire galvanising—and he was speaking specially from that point of view—should be practically negligible in many months of working. In some of the tables in the paper the author seemed to have missed the practical aspect altogether. For instance, in Tables III. and IV. reference was made to certain times and temperatures which were altogether outside any practical experience. A temperature of drying of 150 deg. Cent. was mentioned, but so far as wire galvanising was concerned, the temperature never exceeded the boiling point of the flux, whilst the time of drying would never be in excess of a few seconds—five seconds would be a very liberal estimate. The author mentioned a concentrated zinc chloride solution, but that was very vague. Actually, it sounded as if it were a strong solution, and personally, he would hesitate in ordinary wire galvanising work to use anything greater than a 5 per cent. zinc chloride solution. Reference was also made in the paper to a saturated zinc chloride solution, and that suggested a solution, speaking from the practical point of view, which might be a nasty, treacly mess which would be quite impossible to use for any reasonable form of galvanising. In connection with the theory of the mechanism of fluxing in galvanising, the author made the general statement that if a strip of mild steel was cleaned with emery paper and dipped in the molten zinc, there would be no coating. If that were true, it would be very useful for the industry because all that would be necessary would be to clean the inside of the galvanising baths with emery and then, presumably, they would last for ever. He only wished that could be so. That brought him to the crux of the whole matter. Practical experience showed that the very source of formation of dross in galvanising was not the wire itself, nor the flux on the wire, but the mass of iron of which the bath was constructed, and the rollers, &c., which were immersed in the zinc and which were revolving, causing a certain amount of turbulence which, undoubtedly, increased the rate of solution. That, he maintained, was the real source of the bulk of the volume of dross which was formed in a well-controlled galvanising process. If the wire was run straight from the hydrochloric acid bath into the zinc bath, then masses of dross would be formed and it would be a very expensive process; but if the operations were controlled properly and the wire was introduced into the bath reasonably clean, the amount of dross formed by the wire, he was quite convinced, would be negligible.

Mr. W. R. Lysaght said many years ago the proportion of ferrous to non-ferrous in galvanised material was 85 per cent. ferrous and 15 per cent. non-ferrous; but to-day the figures were more nearly 95 per cent. ferrous and 5 per cent. non-ferrous. At any rate, he believed that was the position in Japan to-day.

Mr. Daniels, replying to the discussion, said it was clearly shown in the paper how the dross could be cut down considerably. He had shown the sources of dross and how they could be controlled, but he felt that the evidence indicated that the flux itself was a source of dross which could not be entirely eliminated. During the past few days he had carried out some experiments using a flux which had practically no connection with the steel, but which acted quite definitely as a flux. The material was cleaned to enable it to be galvanised with a perfectly continuous coating, and the dross in that case was cut down to about 0·04 gramme per square metre of surface, whilst the amount of dross per square metre of surface in Table V. of the paper was 0·36 gramme. Thus, the amount was capable of being reduced as compared with the production by the zinc chloride solution, but did not disappear entirely. Dealing with the question of heating time mentioned by Mr. Rylands, and also the temperature, he said that matter had been investigated, because he had seen articles in galvanising works left over an open coke fire for twenty minutes while the galvaniser was doing something to the bath. In wire galvanising, where things were carried out much more efficiently, the flux might be dried off at 110 deg. Cent. and in a few seconds, as mentioned by Mr. Rylands; but there were cases where the time was very much longer than that, and he was perfectly convinced that time and temperature had a very marked effect upon the flux, and the point had been investigated to show exactly what the conditions were. The concentrated zinc chloride solution was saturated at room temperature. With regard to dross formation, in some experiments he had carried out it appeared that if the temperature of the zinc in contact with the steel surface never got above 480 deg. Cent. the dross which was formed as a result of reaction between the steel and the zinc never left the zinc surface and formed dross at the bottom of the galvanising kettle. It was stated in the paper that under normal conditions the reaction between the zinc and the steel could not form dross, and he still maintained that that was true. The abnormal conditions were such as were very rarely met with in galvanising practice. One of them, for example, was the addition of 1 per cent. cadmium to the zinc bath, but no practical galvaniser would think of doing that. Another condition for the formation of dross from the reaction between the zinc and the steel was the use of steel containing ferrous alloying elements, such as nickel and chromium. That caused a considerable amount of dross when acted upon by ordinary zinc. He had come across cases where a great deal of dross had been definitely formed from the zinc surface by the action of the zinc on steel which was full of silicon and rich in phosphorous and sulphur.

A cordial vote of thanks was passed to the author at the conclusion of the discussion, and the Joint Meeting closed, separate meetings of the two Institutes being held in the afternoon and also on Wednesday morning, September 14th. Reports of these meetings will follow in later issues.

IRON AND STEEL INSTITUTE.

It was announced at the afternoon session of the Iron and Steel Institute on Tuesday that the Council had selected Mr. William R. Lysaght, C.B.E., to succeed Sir Charles Wright, Bart., as President, as from the next annual meeting.

(To be continued.)

OBITUARY.

MR. W. E. GOWER.

We hear with regret of the death in London, on September 11th, of Mr. W. E. Gower, who was a familiar figure at the meetings of the Institution of Municipal Engineers and well known to many power engineers, both at home and abroad. He had an interesting engineering career, beginning with Nettlefolds and other English firms and extending to Canada, where he spent some years handling economisers and mechanical stokers. As a result of his experience in the Dominion he was invited to return home to join the newly formed Underfeed Stoker Company, Ltd. He accepted and for a time had his headquarters in London, but subsequently it was found necessary to open an office in Manchester, of which he undertook the organisation and retained the management until his retirement eight years ago. He was eighty-three years of age.

* See Vanick and Merica, who give the following composition ranges for "Ni-resist":—Total carbon 2·75–3·10, silicon 1·25–2·00, manganese 1·00–1·50, nickel 12–15, copper 5–7, and chromium 1·5–4·0 per cent.

Barking-Upminster Electrification.

No. II. (*conclusion*).*

MERCURY ARC RECTIFIERS.

For the Upney sub-station the General Electric Company has supplied two 1200-kW mercury arc rectifiers, which are fed with current from the 11,000-volt, three-phase, 50-cycle system through two G.E.C. three-six-phase transformers, and like the plant at Hornchurch and Upminster, that at Upney is controlled from the rotary converter sub-station at Heathway. The circular top plate of each rectifier carries the main and auxiliary anodes, condensation cylinder, ignition solenoid, &c., so that when the plate is lifted the anodes and cathode can easily be inspected, and if necessary the anodes, ignition solenoid, and valve can be removed individually. While it has been customary to use porcelain for insulating the anodes and porcelain-to-metal joints have consequently been employed, the makers of these rectifiers contend that such joints are not ideal. By the use of a fused-up insulating seal on these G.E.C. rectifiers, the removal of an anode only entails breaking a metal-to-metal joint, resembling that of an engine cylinder cover. When porcelain is employed, the makers explain, each anode requires two such joints, one at the top and one at the bottom of the insulator. Strong springs are necessary under the holding-down bolt head or stud nuts in order to permit of movement due to the difference in the coefficients of expansion of the steel and porcelain. The special seal used consists of top and bottom members with iron cones between them, separated by special vitreous enamel or glass, having a coefficient of expansion similar to that of the iron. After the cones have been coated with enamel separately and after assembly, the whole seal is fused up solid in a furnace, the temperature of which is under very close control. As the adhesion between the enamel and iron is great, a thoroughly strong seal with a high dielectric strength is produced. Moreover, it is claimed that these joints reduce the air leakage into the rectifier to a negligible amount, whilst the absence of studs, springs, &c., gives the top plate a clean appearance.

The twelve anodes of each of the rectifiers shown in Fig. 9 on page 306, are arranged in pairs, which are connected in parallel to form a six-phase system. The tops of the anode stems have natural air-cooled radiators, whilst the condensing chamber with a water-cooled jacket surrounds the centre of the top plate. The starting anode is actuated by a solenoid, which when energised dips this anode into the mercury pool in the well-known way, the anode being connected to a D.C. supply provided by a small motor generator set. To start the rectifier the main oil circuit breaker is closed, thus energising the rectifier transformer, which, in turn, energises the main anodes, when the starting anode operates as described. As soon as the starting anode is withdrawn from the mercury pool the arc formed is transferred to the auxiliary anodes, and, in turn, to the main anodes. The first-stage vacuum pump is a mercury diffusion pump, and the second-stage unit a rotary box pump, which is driven by a small A.C. motor from the 230-volt operating supply.

Between the two stages there is an inter-stage reservoir which makes it unnecessary for the rotary pump to work continuously. A manometer gauge on this inter-stage reservoir automatically controls the pump motor, which is started when the pressure in the reservoir reaches 15 mm. of mercury, and is stopped when the pressure falls to 2 mm. of mercury. The diffusion pump, which is capable of exhausting the rectifier chamber from about 15 mm. pressure down to the minimum value of 0·001 mm., is energised by a heater consuming approximately 1 kW. As this pump is in continuous operation, the rectifier is ready for immediate operation at all times. The heater associated with this pump boils mercury, and the vapour is discharged through nozzles in which air is picked up in the vapour stream, and is delivered into the inter-stage reservoir, the mercury vapour being separated from the air in a water-cooled condensing chamber, and the liquid mercury returned to the boiling chamber. A current relay in series with the diffusion pump heater prevents operation of the rectifier if the diffusion pump is not working, while a mercury non-return valve on the inter-stage reservoir seals the reservoir from the atmosphere when the rotary pump has shut down. A thermostat ensures that in very cold weather the rectifier is raised to a suitable temperature by means of a heater before it can be started. A closed circuit water-cooling system completely insulated from earth is provided, and the water is circulated through the rectifier and an air cooler by a centrifugal pump. A conservator tank fitted with a level indicating device carries 50 gallons of water. The cooling water enters at the bottom of the rectifier, flows round the mercury pool, then up through a jacket, round the main tank, and thence through ducts cut in the top plate on which the anodes are mounted.

The starting operations occur in the following sequence:—(*a*) The main oil circuit breaker connects the 11,000-volt supply to the main transformer; (*b*) if necessary, the thermostat closes a contactor,

* No. I. appeared September 16th.

which energises the tank heater ; (*c*) when the rectifier has attained the necessary temperature, the thermostat cuts off the supply to the heater ; (*d*) the main cooling system comes into operation ; (*e*) the rectifier ignites and the anodes are energised ; and (*f*) a signal is given at Heathway indicating that the D.C. circuit breakers may be closed.

The D.C. side of each rectifier is protected by a high-speed circuit breaker, arranged to trip in the event of a reverse current, such as would flow on the occurrence of "back fires," whilst on the other pole there is a breaker arranged to trip on overload. An over-temperature relay fitted on the top plate trips the main oil circuit breaker in the event of this plate reaching a dangerous temperature, and when the plate has been cooled down to a suitable value by the cooling system, the rectifier restarts automatically. A relay operated by a Pirani gauge prevents the rectifier being started up if the pressure is above 0·01 mm. of mercury, and shuts down the rectifier if excess pressure is reached, while the equipment is working. In each of the circulating water systems there is a water flow relay which prevents the rectifier being ignited without a proper flow of cooling water, and which shuts down the rectifier in the event of the water supply failing during operation of the plant. As the heater of the diffusion pump is in series with a current relay, the plant cannot operate unless this relay is energised. Other protective devices are a no-volt release of the self-resetting type on the main oil circuit breaker and an inverse time limit overload and leakage relay on the E.H.T. side of the main transformer. All small motors driving pumps, &c., are protected by overload relays with time lags. Both of the sets can be started up from the Heathway sub-station by the Bertram Thomas remote control gear, and the bus-bar voltage and D.C. load on each set can be read at Heathway. Means are provided on the rectifier sub-station panel for changing over from remote to local control when all the protective features described are still effective.

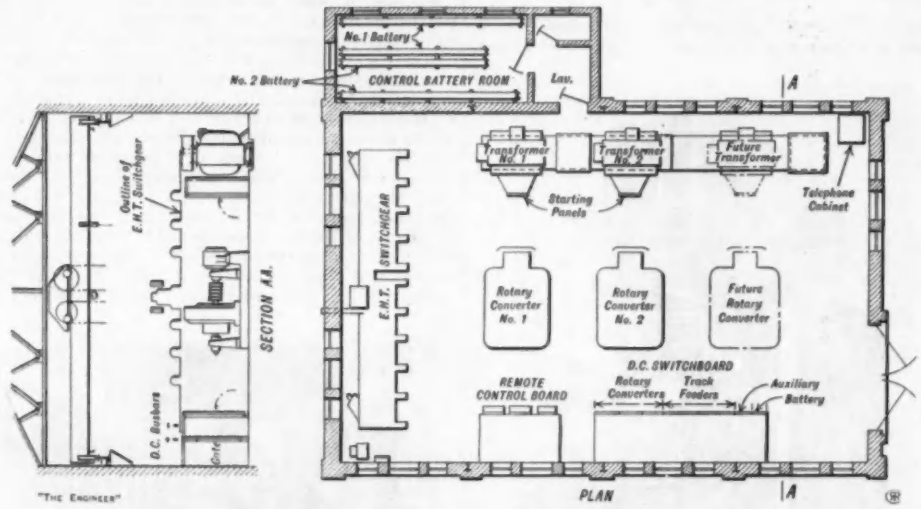


FIG. 11—HEATHWAY SUB-STATION

CONVERTERS.

The G.E.C. converting plant in the Heathway sub-station, shown in the drawing, Fig. 11, and in Fig. 10 on page 306, consists of two 1200-kW, 630-volt, 600-r.p.m. rotary converters, supplied with A.C. from the 11,000-volt, three-phase, 50-cycle system, through two 11,000/465-volt G.E.C. transformers. Arc shields are fitted between each set of brush holders and to the stationary part of the machine to protect the field windings. Speed-limiting and oscillating devices and the usual field regulator are also provided. Both machines are capable of carrying a 25 per cent. overload for two hours without undue heating, and a maximum overload of 300 per cent. without flashing over or falling out of synchronism. The main D.C. Bertram Thomas manually operated switchboard at Heathway is shown in Fig. 12, and the main control panel in that station for controlling the plant at the other three stations in Fig. 13. The local control panel at Upminster is shown in Fig. 14, and an automatic remote-controlled rotary starting panel at Upminster in Fig. 15. Fig. 16 shows the G.E.C. rectifier control panel at Upney.

REMOTE CONTROL.

Although we have referred in a general way to the Bertram Thomas remote control equipment, further details may prove of interest. At Heathway where, as we have said, current is supplied to the system by the County of London Electric Supply Company, there are two incoming E.H.T. feeder oil circuit breakers for the supply. Two other oil circuit breakers serve for two outgoing feeders to Upney, where there are two corresponding incoming circuit breakers and one outgoing breaker for feeding in the opposite direction. In a similar way two outgoing oil circuit breakers at Heathway connect two E.H.T. feeders to the Hornchurch station, which has two corresponding incoming breakers. The outgoing breakers at Hornchurch connect cables to Upminster, where there are only two incoming breakers. Parallel feeder protection is provided, and besides the oil feeder circuit breakers mentioned, there are two other breakers in each sub-station for the operation of the plant installed. In each sub-station the bus-bars and switches are divided into two groups, which, however, can be coupled together. All the oil switches in the Heathway station are hand operated, whilst in the remote-controlled sub-stations they are operated by small motors, fed from the battery at Heathway. Each converting equipment and each feeder switch in the remote controlled stations has its own separate pilot wire connecting up to Heathway, and by means of this wire the oil switch can be opened or closed by the operator at Heathway and a continuous indication is given of either of the two operations performed.

All current required for the remote controlled sub-stations is supplied by the duplicate batteries at Heathway, each sub-station being connected by a pair of battery pilot wires. The batteries are charged from the 630-volt circuit through resistances and multi-contact switches, and, as explained in the first article, whilst one battery is receiving current the other is in use or is standing in reserve. As at each sub-station the up and down insulated rails of the two tracks are separated, there are four pairs of insulated rail ends. The four positive ends are connected to the bus-bars through four Bertram Thomas motor-operated circuit breakers which are interlocked with four contactors connecting the four negative rail ends to the negative bus-bars. Each negative contactor opens and closes with the corresponding high-speed positive breaker, but the contactors do not operate at high speed. As the oil switches and high-speed breakers on the feeders are all motor operated and can be worked from the battery pilots, it is possible to open or close any E.H.T. circuit breaker or any track feeder circuit breaker from Heathway irrespective of whether the line is alive or not, for each E.H.T. and track feeder breaker has its own separate pilot wire connection to Heathway. By pressing a "Close" or "Open" push button at Heathway the corresponding breaker can be operated as desired and a permanent indication is given of the state of affairs. In the event of any circuit breaker opening under load a bell rings at Heathway and a red light shows which circuit is affected.

Although the equipment of the various sub-stations differs, as far as possible the remote-control gear and 630-volt D.C. gear have been made similar. At Heathway, where the G.E.C. rotaries are in use and where the plant is operated by hand, each machine has two main isolating switches and two panel type normal speed circuit breakers. The ordinary starting equipment for running up and synchronising the rotary converters before they are connected to the line is, of course, also provided. The equipment consists of a triple-pole circuit breaker for the pilot motor, a triple-pole starting switch, and a running switch which is closed when the machine has been synchronised. An ammeter, voltmeter, and field reversing switch are also provided. For the rectifiers at Upney and Hornchurch each equipment has its own separate pilot wire extending to Heathway. By pressing a "Start" button at the latter station a master contactor is made to close and remain closed. If the plant is in a suitable condition for starting, the interlocks allow the current to be automatically switched on to the oil switch motor and the switch closes and connects up the high-tension switch to the rectifier, the operator at Heathway being automatically notified that this operation has occurred. When the conditions necessary for connecting up on the D.C. side have been met it is possible to switch the rectifier on to the 630-volt bus-bars by means of the high-speed circuit breaker on the positive side and the contactor on the negative side, which are closed, when permitted by interlocks, by pressing a "Close breaker" push button at Heathway. When the rectifier is on load and the oil switch, high-speed breaker and contactor are closed, in the event of any one of these breakers opening the other two open. All faults on the outside circuit are taken care of by the track feeder high-speed breakers, which are equipped with overload devices adjustable between 2500 and 5000 ampères. Whilst the oil circuit breakers are closed by small motors fed from the battery pilot wires, the 630-volt high-speed breakers and contactors are closed by solenoids energised from the plant. As at Upney reverse current and overload protection is provided at Hornchurch.

Naturally, the rotary converter equipment at the

FIG. 12—D.C. MANUALLY-OPERATED SWITCHBOARD AT HEATHWAY

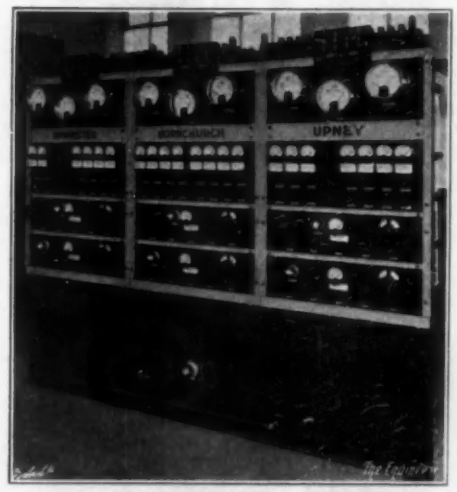


FIG. 13—SUB-STATION CONTROL PANEL

Upminster sub-station has necessitated the provision of different remote control to that employed at the rectifier sub-stations. On pressing the "Start" push button at Heathway a master contactor closes at Upminster and remains closed. This causes a small motor to take current from the battery pilots and it opens the main low-tension A.C. switch. A starting contactor also closes, and by these two operations the pony motor is connected in circuit with the armature of the machine. As soon as the main low-tension A.C. switch has opened current is allowed to pass to the motor of the oil circuit breaker, which closes and connects the machine to the E.H.T. mains through the transformer when the machine starts and eventually pulls into synchronism. The synchronised condition actuates a relay, and after a few seconds the main low-tension A.C. switch is closed and the starting motor is cut out of circuit. This condition is indicated at the control board, and by pressing the "Close breaker" push button the operator causes the high-speed circuit breaker and its contactor to close, thereby connecting the machine to the D.C. bus-bars. Although each converter is provided with its own hand-operated rheostat, they are left in a set condition while the machines are in service. There is no difficulty, we are told, in putting a rotary converter into operation in less than one minute. As in the case of the feeder breakers, in the event of any rectifier or rotary circuit breaker or oil switch opening a bell rings at Heathway and a red light shows which machine or rectifier is affected.

Each sub-station is controlled by a combination panel, approximately 3ft. wide and 7ft. high. Taking

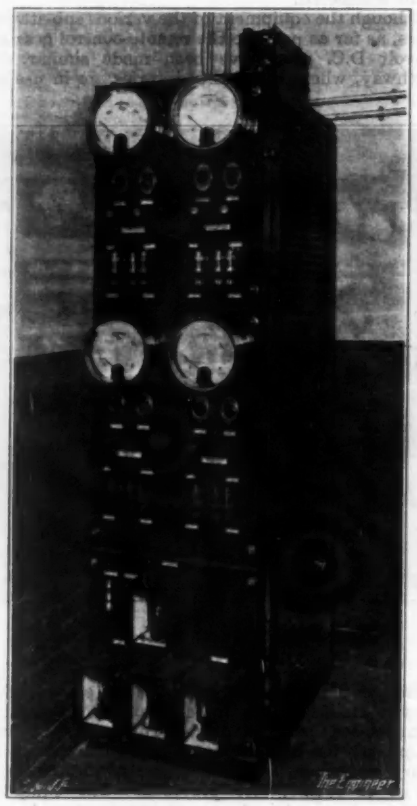


FIG. 14—LOCAL CONTROL PANEL

the Hornchurch station as typical, a top panel, 2ft. 9in. wide by 1ft. deep, carries an ammeter reading up to 8000 ampères and two voltmeters reading up to 750 volts. The ammeter is connected to a shunt between the rectifier and bus-bars and feeders, and therefore measures the whole of the output of the station. One voltmeter gives a continuous indication of the bus-bar voltage, whilst the other can be used to indicate the voltage of an incoming rectifier. The panel below this, which is 2ft. 9in. wide and 1ft. 2in. deep, carries the equipment for controlling the E.H.T. and track feeder circuit breakers. In the case of Hornchurch there are four E.H.T. feeders and four track circuit breakers, and for each there is an indicator with an illuminated label with "Close" and "Open" push buttons. Below these are two rectifier control panels, which are similarly equipped, and there is space for a third in the event of the plant being extended. Each of these panels carries an indicator, an alarm relay, and a switch for obtaining a voltage reading before paralleling, whilst at a lower level it carries push buttons marked "Start," "Stop," "Close breaker," and "Open breaker." The contract for the whole of the switchgear and remote-control gear described was awarded to Bertram Thomas, but the E.H.T. gear was manufactured for that firm by A. Reyrolle and Co., of Hebburn-on-Tyne.

SIGNALLING.

In connection with the widened lines between Barking East signal-box and Upminster West signal-box, automatic and semi-automatic colour light signals have been provided, the signals being of the searchlight type with a very high beam candle-power, similar to those recently installed at Mirfield on the L.M.S. Railway. Marker lights are fixed below the signal units, and when the signal exhibits a red light with a red marker below the indication is "Stop and stay." The marker light shows red when the signal unit exhibits red or yellow, and is extinguished when the signal unit exhibits green, the red marker light thus enabling the yellow signal light to be correctly appraised. The indications normally displayed are :—

Signal Unit.	Marker.	
Red	Red	Stop and Stay.
Yellow	Red	Caution. Prepare to stop at next signal.
Green	Out	All right. Proceed.

All stop signals are provided with train stops which work in conjunction with the signals and track

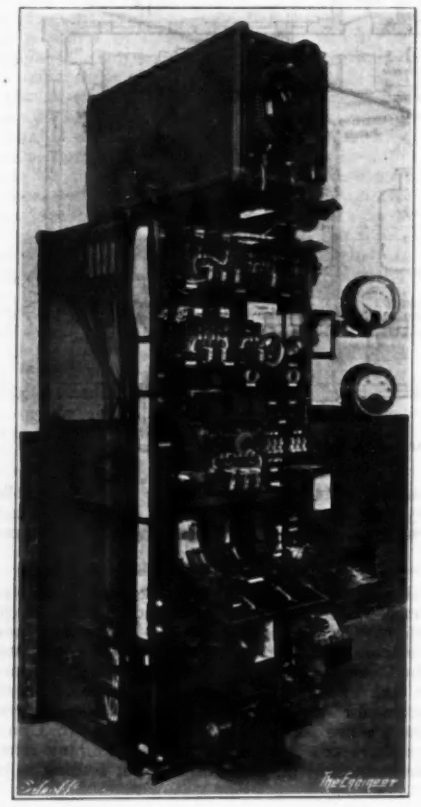


FIG. 15—REMOTE-CONTROLLED STARTING PANEL

circuits. When a signal is at danger they project an arm which engages with a trip cock on the train, and, owing to the provision of an overlap circuit in connection with all stop signals, in the event of a train running past a signal at danger, it is brought to rest within the overlap length. In the case of long sections of automatic signalling with train stops, in the event of a failure of the track circuits holding the signals at danger, considerable delay can occur, and in order to minimise the trouble it is usual to permit purely automatic signals to be passed when at danger after waiting one minute. On the lines under consideration, however, the permission to pass after one minute is given automatically by the marker light changing from red to a small yellow light, which indicates that the train may proceed cautiously as far as the line is clear. As the indication is only given when the train stop has been wound off, the motorman does not have to get down to re-set his train stop apparatus, as is necessary when ordinary automatic signals are passed at danger. At the various signal-boxes there are illuminated diagrams. When a track circuit is clear, no light is shown on the diagram, but when it is occupied two red spot lights appear. Special telephone circuits are provided for communication between trainmen and signalmen; there are also telephones for traffic control purposes, and for communication between the sub-stations. The signalling has been designed to give an approximate headway of four minutes between the electric trains, and the spacing of the signals has been arranged to accommodate steam trains on the lines. The track circuits in the colour-light area are of the A.C. phase-controlled, constant-current type. In the majority of cases the feed apparatus and relays are housed in cases at the side of the line, or in the relay huts at the signal-boxes, current for the track circuits and signalling installations being supplied from the four sub-stations.

During non-rush hours a twenty-minutes service of electric trains with seating accommodation for 200 passengers is being maintained, whilst during the morning and evening rush hours the service is considerably strengthened. Between 6.30 a.m. and 9.30 a.m. sixteen trains, holding 400 passengers, leave Upminster, and five run from Dagenham. From 5 p.m. to 7.15 p.m. fifteen trains arrive at Upminster and two at Dagenham. As shown in the map published in our last issue, from Barking the passenger stations on the new line are Upney, Becontree, Heathway, Dagenham, Hornchurch and Upminster, and as explained Upney and Heathway, served by the electric trains alone, are entirely new. Becontree, a four-platformed station serving the London County Council Becontree estate, replaces Gale-street, while Dagenham, Hornchurch and Upminster have been remodelled and modernised. In each case the booking office accommodation, which is equipped, where possible, with passimeters, is on the road level, with connecting covered subways to the platforms, which are 700ft. long and covered for a distance of 300ft.

Besides the work we have mentioned, the construction of the line has involved the excavation of 400,000 cubic yards of material, the rebuilding and, in some cases, the widening of twenty-one bridges, eleven of them being road bridges; the construction of new goods yards at Hornchurch; new signal-boxes at Hornchurch and Upminster, and the remodelling of the goods yard and motive power accommodation, and the provision of six new carriage sidings at Upminster. The general contractors for the scheme were Harold Arnold and Sons, Ltd., of Doncaster. For the steelwork for bridges, &c., the Butterley Company, of Derby, was responsible; for the stations and new locomotive depôt at Upminster, Charles Booth and Sons, of Bradford; for the four sub-stations, E. Wood and Co., of Derby, and for the

FIG. 16—RECTIFIER CONTROL PANEL

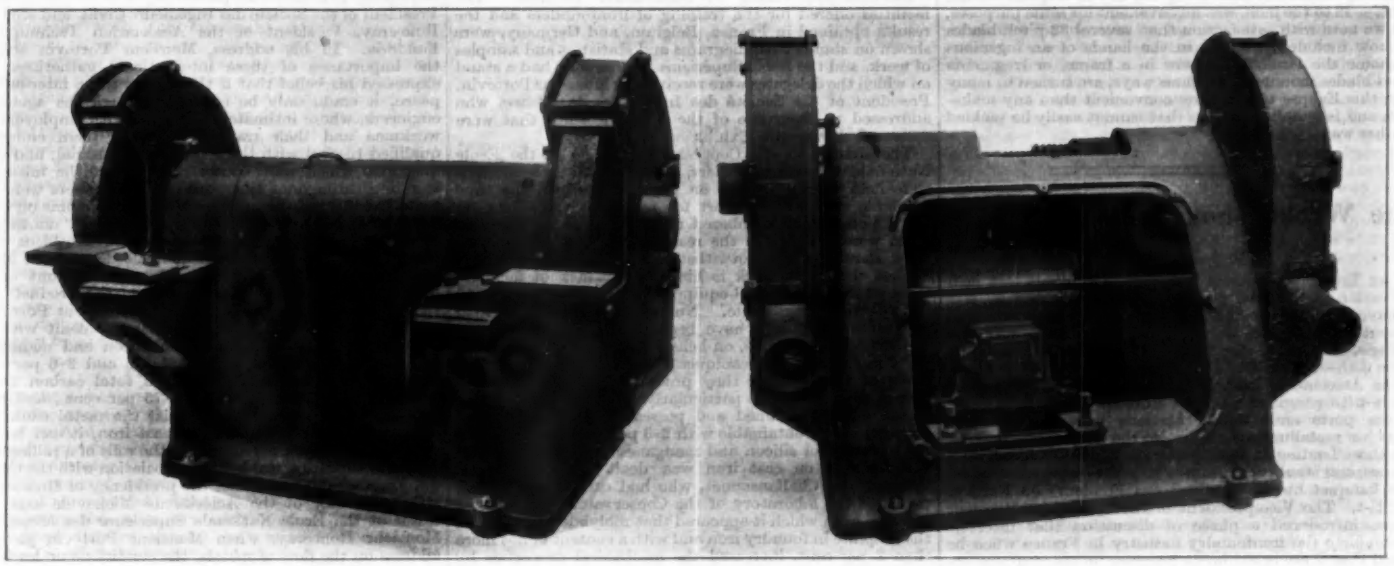
reinforced concrete for platforms and walling, John Ellis and Sons, Ltd., of Leicester.

The colour-light signalling installation, including signals, train stops, track circuits, illuminated diagrams, circuit controllers and indicators, &c., was carried out by the British Power Signal Company, Ltd., of 3, Central-buildings, S.W., whilst the cable work and that associated with telephones, the semaphore signalling and track circuiting at Barking East, the signal-boxes, mechanically worked points and semaphore signals at Dagenham, Hornchurch and Upminster, was dealt with by the railway company. The installation was carried out to the designs and under the general supervision of the railway company's signal and telegraph engineer, Mr. A. F. Bound; the divisional signal and telegraph engineer, Mr. A. Oldham, being responsible for the actual execution of the work.

A Grinder for Bakelite-Bonded Wheels.

DURING the past few years a method of bonding the abrasive in bakelite wheels has been developed. Such wheels may be run at surface speeds up to 9000ft. per minute, and are suitable for snagging and fettling operations. Owing to the fact that the speed at which they may be used is nearly double that of the ordinary vitrified wheel they offer considerable advantages in the way of high productivity. The machine illustrated by the accompanying engravings has been designed by B. R. Rowland

GRINDING MACHINE FOR BAKELITE-BONDED WHEELS



and Co., Ltd., for use with bakelite bonded wheels of their own make. The wheels are 30in. in diameter by 4in. wide, and one is mounted at each end of a high tensile steel spindle running in large size anti-friction bearings, of which the housings are equipped with "labyrinth" grease seals to exclude dirt and grit. Solid steel adjustable guards surrounding each grinding wheel protect the operator in the unlikely event of a wheel bursting. Access to the spindle end for changing a wheel is obtained by unscrewing four nuts and opening the side door, which swings on hinges at the back. Within the base of the machine and accessible from a door at the back a 15 H.P. electric motor driving the spindle through multiple V belts is mounted on a hinged foundation. In order that as the wheels wear the surface speed may be maintained, there are three stepped pulleys on the main spindle. Instead of mounting stepped pulleys on the motor, it is made adjustable along a feather key. All the bearings throughout are lubricated on the Tecalemit high-pressure system. The grinding rests are adjustable to suit the diameters of the wheels as they wear. The pipes leading from the interior of the guards, which are to be seen in the engraving showing the back of the machine, are connected to a dust-exhausting apparatus driven by a single belt from the motor. The fan, which is mounted on ball bearings, may be arranged to discharge to any suitable duct. In order to comply with Home Office regulations concerning the speed above which grinding wheels must not be run, an attachment is provided which automatically obviates any possibility that either of the wheels may be run at an excessive speed above 9000 surface feet per minute. Besides that illustrated, the machine is made in two other sizes capable of carrying a 24in. by 3in. and an 18in. by 2½in. wheel, and driven by a 12 H.P. and an 8 H.P. motor respectively.

A Mobile Truck Crane.

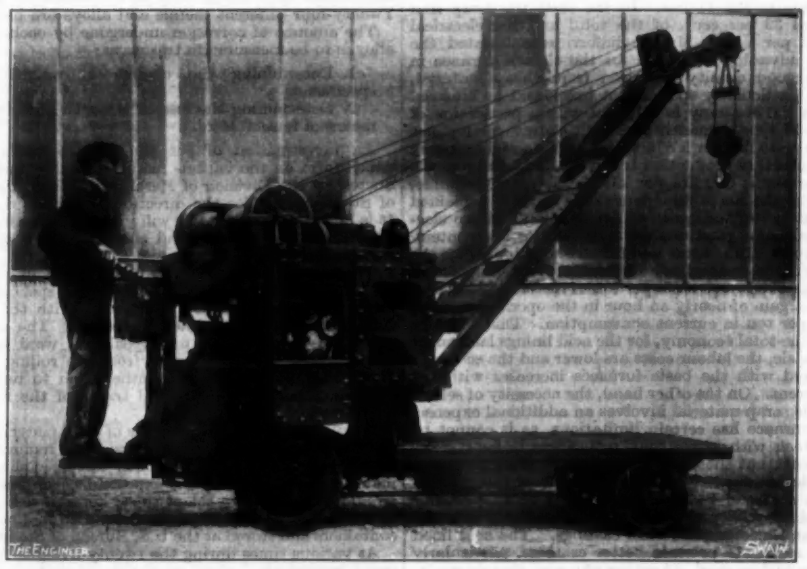
THE 1-ton truck type mobile crane shown in the accompanying illustration has been developed by Ransome and Rapier, Ltd., of Ipswich, to meet the need for a truck carrier that can do its loading and unloading independently of external cranes, and thus save time. It is suitable for use in works, warehouses, and goods depôts, &c., where there are no lifting arrangements, and is claimed considerably to increase the usefulness of truck transportation.

In common with all the Ransome and Rapier mobile cranes, it operates on the petrol-electric system with patented variable voltage control, combining the advantages of a petrol prime mover with a separate motor drive for the derrick hoist, slew, and travel motions. The variable voltage control system without relays or resistances gives smooth starting and running. There are no power storage batteries or trailing cables or clutches, and as the crane is self-contained it can work anywhere. It is only necessary to move the appropriate switch handle and to accelerate the petrol engine to bring any motion into operation, and, if necessary, more than one motion can be worked at the same time. An abridged specification of the crane is given below :—

Working loads	1 ton at 7ft. radius 14 cwt. at 11ft. radius 9 cwt. at 15ft. radius
Hoisting speed	Full load, 15ft. per min.
Travelling speed	Up to 6 miles per hour
Slewing full range of 244 deg.	14 sec.
Derricking full range	15 sec.
Maximum wheel loads—	
In working order, no load	1½ tons
1 ton at 7ft. radius, jib straight ahead	1½ tons
1 ton at 7ft. radius, jib over side	3½ tons
Height with jib lowered	5ft. 10in.
Width overall	4ft.
Wheel base	6ft. 3in.
Ground clearance	4½in.
Loading platform area	3ft. 11in. wide, 5ft. 6in. long
Tail radius of superstructure	4ft.
Length with jib raised, platform pedals and tiller hinged up	11ft. 3in.
Weight of crane in working order	3½ tons

Tiller operated four-wheel steering, combined with the makers' patented method of control which gives full travelling speed control from standing to full speed, ensures easy manipulation. The crane is said to be stable on its own wheels without outriggers or props, when the load is being lifted with the superstructure in any position. The superstructure, which carries the petrol engine generator set, other machinery, and jib, is mounted on a substantial steel post fixed to the truck, both axles of which being mounted on springs.

The hoist gear consists of a large diameter machine-grooved winding barrel, which is driven through totally enclosed worm and spur gearing, running in an oil bath, by a waterproof electric motor of ample rating, the barrel being of sufficient length to wind the whole of the rope without overlapping of the coils. The derrick gear is of similar design and the motor and gear are interchangeable with those of the hoist gear. A waterproof motor driving through a train of worm and spur on to a spur ring fixed to the superstructure serves for slewing, whilst a waterproof motor transmitting its power through worm and differential gear drives the two large steerable road wheels, which are carried on hollow stub axles. The driving axles are thus of the full floating type with universal knuckles to give the flexibility of drive necessary for steering.



PETROL-ELECTRIC MOBILE TRUCK CRANE

The shoe type travel brake which engages with a brake drum on the travel motor shaft is operated by one of the platform pedals, and unless the operator is standing on the pedal, the brake is always "on." A shoe type brake operated by a ratcheted hand lever at the control platform is provided for the slew motion. Both the hoist and derrick motions are fitted with a "Lewis" patented self-adjusting electro-magnetic brake, which operates immediately the current is cut off from the motors, both brakes being interchangeable.

As will be gathered from the illustration, the crane is carried on four solid rubber-tired road wheels, which are mounted on ball and roller bearings. The telescopic jib gives a maximum length of 17ft., and is adjustable in 1ft. stages to a minimum length of 12ft., but any reasonable length of telescopic or fixed jib can be supplied to suit requirements. Limit switches are provided to minimise the effect of overwinding the hoist motion in the hoisting direction, and the derricking motion in the inward direction. The slew motion has buffer stops for each limit, and is fitted with a slipping clutch. The petrol set has an electric starter and a 12-volt battery, electric horn, and the necessary instruments complete the electrical equipment.

On the operator's platform there are two hinged pedals which spring to the "up" position when released. The left-hand pedal is connected to the travel brake and the right-hand one to the engine accelerator handle, so that the travel brake cannot be released or the engine accelerated unless the operator is standing on the pedals. On the left of the platform there is a horizontal tiller for four-wheel steering, and on the right-hand side the engine accelerator handle. The selector controls immediately in front of the driver consist of four handle operated reversing switches for the derrick, hoist, slew, and travel motions. Speed control is effected by the engine accelerator pedals. When the engine is started, it runs at a "ticking over" speed, which is insufficient to excite the generator, and when the crane is to be used the appropriate selectors are engaged and the motion is started and controlled by the engine accelerator handle.

All gears have machine-cut teeth, and are cut from solid blanks. With the exception of the final motions of the slew gear, they are all enclosed in oil baths. Where oil baths are not provided for lubrication, there are nipples for lubrication by means of a grease gun. Special high-grade materials are used for all gears, shafts, and bearings, and alloy steels are employed for gears and shafts in all cases where advantage can be so gained in durability and efficiency.

The Eclipse 4S Tool.

IN our issue of December 11th, 1931, we gave a short description of a handy sawing and scraping equipment which had been sent to us by the makers, James Neil and Co. (Sheffield), Ltd., of Napier-street, Sheffield. The equipment consists of a nickel-plated handle, to which short lengths of specially shaped blades can be rapidly attached. From one end the blades project straight, whilst at the other they are set at an angle so that the tool may be used for special jobs or in awkward places. We learn from the makers that the tool, with many blades, all packed in a small tin box and sold for a few shillings, has "caught on," and that, in consequence of its popularity, several improvements have been effected. Amongst these improvements we note that the corners of the handle have been more generously rounded with an increase of comfort, and that in the equipment of

blades there is now included a second cut flat file with one safe edge, and a special 18-gauge slotting blade for undercutting the mica of commutators. Our own experience has shown us that the pitch of the original blades, namely, 22 to the inch, was inconvenient for some purposes, and we note with satisfaction that several 32-pitch blades are now included. Whilst in the hands of an ingenious mechanic the familiar hacksaw in a frame, or fragments of old blades mounted in various ways, are turned to many uses, this Eclipse tool is more convenient than any makeshift, and is suitable for jobs that cannot easily be tackled in other ways.

The World's Foundry Congress in Paris.

THE Triennial Foundry Congress, which was last held in London in 1929 and previously at Detroit, U.S.A., was to have taken place this year in Germany, but owing to present circumstances Germany waived its claim in favour of Paris, which thus, for the third time, held the Congress —the fifth—last week. The organisation was in the hands of the Association Technique de Fonderie, which carried it out with complete success. Foreign delegates arriving at the ports and frontier stations were convoyed on visits to metallurgical works in the respective regions, and those landing at Boulogne were taken to Lille, Valenciennes, and Maubeuge, while at Lille they were entertained at a banquet by the Syndicat des Fondeurs du Nord et de l'Est. The Vice-president of the Syndicate, Monsieur Dispa, introduced a phase of discussion that interests particularly the ironfoundry industry in France when he stated that there could be no progress unless ironfounders were relieved of the worries attendant on selling prices. The Syndicat Général des Fondeurs du Nord et de l'Est was constituted six years ago, with a view to maintaining prices at an average level that would enable the industry to live. Much had already been done in the face of great difficulties to attain that end, but more would have to be accomplished in order to ensure perfect discipline throughout the industry. In the Nord there are 183 ironfounders producing 15,000 tons of castings a month, and Monsieur Dispa was confident that all of them would see that their interests were inseparable from a sound organisation, and that the example of the northern ironfounders would be followed by those in other parts of the country.

The inaugural meeting was held at the Sorbonne in Paris, when Monsieur E. Ronceray, President of the Association Technique de Fonderie, delivered an address of welcome. He was followed by Mr. A. Harley, President of the International Committee of Foundry Technical Associations; whilst the Under-Secretary of State for Technical Education spoke of what had already been done to encourage foundry progress in France, particularly through the Ecole Supérieure de Fonderie, and remarked on the vast field of research that was opened up to foundry workers.

The first technical communications were of a practical character, one by Monsieur Ageron, director of one of the foundries of the Société des Hauts-Fourneaux et Fonderies de Pont-à-Mousson, dealt with the prevention of accidents in foundries, and gave figures showing the alarming increase in the number of accidents and the consequent loss of working days to employers since the introduction of legislation for compulsory insurance and the rise of abuses following upon a too-rigid application of that legislation. The best insurance for employers, said Monsieur Ageron, was to do everything possible to prevent accidents, and he showed how, in his foundry, the number of accidents had been reduced by four-fifths during a period of three years, with the result that the general working efficiency had improved and there had been a notable reduction in overhead charges. That meant an expenditure on an effective organisation which Monsieur Ageron fully explained, the main points being that the men were kept constantly alive to the risks of their work with the aid of pictorial and other notices that were frequently changed in form and character, and that the employer adopted safety devices which were described in the communication.

Another communication of a more general character was presented by Monsieur Bloch, chief engineer of the Paris–Orleans Railway Company, who displayed a film showing the organisation of the repair shops, and the remarkable results obtained by eliminating all loss of time, as illustrated by the operations of dismantling a locomotive, repairing parts in the different shops, and reassembling, for which a maximum time was allotted, and in all cases that time was reduced by premiums paid to the men. The interest of that communication lies in the spirit of organisation which is pervading all French industries, and is encouraged and helped by the Comité National de l'Organisation Française, which associated itself with the Foundry Congress. The object is to provide against man shortage in times of activity and to bring down costs to a minimum, which is the only possible way of securing foreign business when industries are burdened with charges from which there appears to be little hope of obtaining relief.

After the inaugural meeting the delegates were received at the Foundry Exhibition, which occupied one of the halls on the exhibition grounds at the Porte de Versailles. The most elaborate exhibits of moulding plants were German, one of the largest being that of the Badische Maschinenfabrik, of Durlach (Baden). The plants were laid out with a view to labour economy, and an installation of large capacity was being run by three men. The method of packing moulds with sand under air pressure, which at one time seemed likely to develop largely, now appears to be confined mainly to the making of small cores. The French exhibits of moulding machines showed progress, though limited to plants of smaller capacity. The castings displayed were in every respect good, particularly those shown by motor car firms, and the Italians had a combined stand containing some remarkable examples of the ironfounder's art, while Itala showed a big lorry frame in one steel casting with beds for the engine and transmission gear. Renault and Citroën had explanatory stands of their methods of production and control. Several metallurgical firms presented individually small exhibits of iron ore, cast iron, and foundry castings, many of these last being special castings with nickel, chrome, molybdenum, and other alloys, and the way in which they were shown, sometimes with micro-photographs, indicated the interest which consumers are taking in ironfoundry progress. The facilities offered for the training of ironfounders and the results obtained in France, Belgium, and Germany, were shown on stands with diagrams and statistics and samples of work, and the Ecole Supérieure de Fonderie had a stand on which the delegates were received by Monsieur Portevin, President of the Société des Ingénieurs de France, who addressed to them one of the public lectures that were delivered during the Exhibition.

The sittings of the Congress took place at the Ecole Nationale des Arts et Métiers, and although three sections were held simultaneously on three afternoons, the time available was far too short for adequate discussions on the papers, which numbered more than forty. Many of them were devoted to the results of research work, and they showed that, notwithstanding the complaints in France that such work is hindered by lack of facilities through the generally ill-equipped laboratories, some good progress is being made. Numerous experiments with low carbon cast iron have been carried out by Messrs. Delbart and Lecoeuvre, on behalf of the Société Française de Constructions Mécaniques (Anciens Etablissements Cail), of Denain, and they produced tables and micrographs showing that a particularly satisfactory hardening metal, easily machined and possessing high mechanical properties, was obtainable with 2·3 per cent. carbon and a high content of silicon and manganese. The influence of molybdenum on cast iron was dealt with by Messrs. Cournot and Challansonnet, who had carried out experiments at the laboratory of the Conservatoire des Arts et Métiers, from which it appeared that molybdenum reduced the graphite in foundry iron and with a content of not more than 2 per cent. increased the mechanical properties by 40 to 60 per cent. The treatment of malleable iron was dealt with by other authors, and Monsieur Le Thomas gave a general survey of the influence of high contents of silicon on the formation of graphite. According to Monsieur Thiery, who replaces a part of the silicon in malleable iron with nickel, the addition of 2 per cent. nickel increases the tensile strength by about 30 per cent. and the elongations were nearly doubled. Chromium increased considerably the hardness of the metal, but reduced the other mechanical properties. As the nickel content increases, the graphite is more finely divided and distributed throughout the mass during annealing. The cementite is replaced by pearlite and this again by ferrite. While some of the papers added to the general knowledge of cast iron mixtures, there was little in the way of new and definite data, and the communications were more particularly useful in guiding research work for the production of special cast irons and, incidentally, in showing the importance attached by the French to such metals, whereby the sections and weights can be cut down. Though nearly all countries were represented at the Congress, there were few foreign communications besides the usual "exchange papers," and amongst these, Herr Meyersberg, of Berlin, read one on behalf of the German Technical Associations on recent developments in ironfoundry in Germany.

Any advance in the use of the electric smelting furnace is a question of prime cost, and also of a closer collaboration between ironfounders and electro-metallurgists, for the ironfounder is reluctant to change his methods, and he is by no means sure that the price at which electric current is supplied is conducive to the economical employment of that source of energy. The conditions have been changed by the cheapness of scrap iron, though how long this will continue it is impossible to say, and electro-metallurgists are now demonstrating the economy of electric smelting. The number of electric furnaces in use is increasing. Mr. Tagliaferri, of Genoa, gave figures of the cost of producing cast iron in cupolas and electric furnaces in Italy. He took three cases of furnaces producing annually 600, 2700, and 5400 tons. In the first case, the furnaces had a capacity of 2 tons an hour and in the others of 3 tons, and they all worked intermittently, except the electric furnace, which ran continuously for 300 days, while two cupolas producing the same quantity worked six hours a day. In the first case the cost per ton of liquid metal in the electric furnace was 331 lira, as against 333 lira in the cupola; in the second case it was 277 lira, as against 330 lira; and in the third case 239·85 lira, as against 329·41 lira. In the costs the scrap iron represented 39 per cent. of the total and the electrical energy 29 per cent. Mr. Tagliaferri recapitulated the numerous advantages claimed for the electric furnace in producing good quality cast iron from cheap material, and more particularly special cast irons, and he affirmed that while the economy is doubtful with a production of less than 50 tons a month and with energy costing not more than 0·15 lira per kWh, there is undoubted economy when the monthly production is 50 tons and more and the cost of current is 0·2 lira per kWh. Monsieur Lemoine, Professor at the Ecole Supérieure de Fonderie, explained the advantages of furnaces with acid lining and arc electrodes smelting a good quality scrap with a low content of phosphorus. In a 2-ton acid furnace working under the same conditions as the basic furnace, the consumption of current was 590 to 620 kWh per ton of metal smelted, and there was a gain of nearly an hour in the operation and of 200 kWh per ton in current consumption. This does not represent the total economy, for the acid linings last longer than the basic, the labour costs are lower and the economy as compared with the basic furnaces increases with the cost of current. On the other hand, the necessity of selecting suitable scrap material involves an additional expense. The acid furnace has certain limitations, as it cannot be used for steels with 12 per cent. manganese or for rustless chrome steels, but these are small limitations, and in any case the electric furnaces designed nowadays can be used with both acid and basic linings, and their adaptability is declared to render them specially useful in foundries for small and medium size steel castings. The acid lined furnace is stated to produce better castings, particularly of ordinary carbon steel. Another phase of electric smelting was dealt with by Monsieur Levasseur, who is Professor at the Ecole Supérieure de Fonderie, and he described results obtained with induction furnaces at normal frequencies with magnetic cores, and showed the economies effected with them under particular conditions of working. The conclusion arrived at from these contributions is that the arc or induction furnace needs to be designed and adapted to the particular work to be undertaken.

One of the sittings of the Congress was held in conjunction with the Société des Ingénieurs Civils in its conference hall under the presidency of Monsieur Portevin, President of the Société des Ingénieurs Civils, and Monsieur Ronceray, President of the Association Technique de Fonderie. In his address, Monsieur Portevin stressed the importance of these international gatherings, and expressed his belief that if there were to be international peace, it could only be effected through the agency of engineers, whose intimate association with employers and workmen and their training rendered them eminently qualified to deal with the economic, industrial, and other questions which were causes of much of the misunderstanding throughout the world. Three papers were presented at this meeting, one by Monsieur Lemoine on basic-lined electric furnaces already summarised, another by Monsieur Ballay in collaboration with Monsieur Léon Guillet, director of the Ecole Centrale des Arts et Manufactures, giving a particularly detailed account of the influences of different constituents on the production of special iron castings, and a third by Monsieur Portier on low-carbon cast iron. Monsieur Portier dealt with the influence of variable contents of silicon and manganese on castings containing a total of 2·5 and 2·6 per cent. carbon; and, finally, settled upon total carbon 2·5 to 2·6 per cent., silicon 2·25 to 2·75 per cent., and manganese 0·5 to 1 per cent. Whilst the metal cannot be machined so easily as ordinary cast iron, it can be hardened to the degree necessary for the rolls of a rolling mill.

The last meeting was held in association with the Comité des Forges de France under the presidency of Monsieur P. Nicou, director of the Aciéries de Micheville and Professor at the Ecole Nationale Supérieure des Mines, and Monsieur Ronceray, when Monsieur Portevin gave an address on the flow of metals, the conditions under which this was effected in moulds, the methods adopted to control the flow by temperature, and the choice of sand for moulds. This concluded the communications, many of them of interest, amongst which may be mentioned, in the non-ferrous section, an exchange paper from the Institute of British Foundrymen by Mr. D. C. E. Hanson, Professor of Metallurgy at the Birmingham University, on some causes of defects in aluminium alloys; while another paper on aluminium alloys by Mr. H. J. Rowe and Mr. E. M. Gingerich, of the Aluminium Company of America, was presented on behalf of the American Foundrymen's Association.

The Congress ended with a banquet under the presidency of the Under-Secretary of State for Technical Education. During the five days, the delegates were entertained in a manner that added greatly to the enjoyment of their visit, and the mornings were devoted to seeing works around Paris, notably the Renault foundries, the Bonvillain and Ronceray foundry, Lobstein, Citroën, and others; and on Sunday they were received at the Château de Rambouillet by the President of the Republic.

Corrosion of Non-Ferrous Metals and Alloys.

THE elaborate and comprehensive test programme for studying corrosion of non-ferrous metals and alloys which is being carried out by Committee B-3 of the American Society for Testing Materials is supported by many of the leading companies of the country. It has been estimated that over the past five years during which extensive tests have been performed and preparations made for the unparalleled series of exposure tests now under way, these companies have contributed over 175,000 dollars in the form of materials, special testing equipment, labour, and funds.

About 23,000 test specimens are being used in phases of the work. Of these, 13,000 are in the form of standard tension test specimens, each carefully machined and finished. The remaining 10,000 are in various forms depending on the type of test.

The most extensive programme is that sponsored by the Sub-Committee on Atmospheric Corrosion. These exposure tests will extend over a period of twenty-five years and involve the use of the greater part of the 23,000 specimens. Twenty-four different metals and alloys are being tested.

The amount of corrosion undergone by each metal and alloy is to be measured in two ways:—

1. Determining the change in weight of plate specimens.
2. Determining the loss in strength and ductility by means of tension tests.

An investigation of the films of corrosion products which form on the various metals and alloys will be conducted by the Division of Metallurgy of the U.S. Bureau of Standards, under the direction of Dr. H. S. Rawdon. It is hoped that this study will yield valuable information regarding the formation and character of protective and non-protective films.

The materials are exposed in the form of plates, 9in. by 12in., 0·035in. thick, and tension test specimens of the same materials machined to conform with the standard A.S.T.M. specimen for sheet materials. The surfaces of the plates and tension test specimens were left in the original condition as received from the rolling mills and given no special preparation other than to remove with benzine, ether, and alcohol all traces of the rolling mill lubricants.

There are four plate specimens of each material exposed at each test location, two designated as "removable," two as "permanent." Thirty tension test specimens of each material under test are also exposed at each test location. In addition, an extra set of thirty tension test specimens of each material was prepared and placed in air-tight glass containers and stored at the U.S. Bureau of Standards.

At various times during the twenty-five year period the two "removable" plate specimens of each material will be taken from their racks and returned to the Bureau of Standards at Washington, D.C., for inspection and weighing. The corroded plate specimens will be weighed just as they are received from the test racks without attempting to remove any surface deposits or films of corrosion products. A set of six tension test specimens of each material will also be removed from the racks and tested to determine

their tensile strength and elongation. At the same time six tension test specimens of each material will be removed from the set stored in the air-tight containers at the Bureau of Standards and their tensile properties determined coincidentally with the specimens which have been corroded in the atmosphere. These latter tests must be made in order to determine what changes may have taken place in the physical properties of the materials through simple ageing so that allowances can be made for such changes in interpreting the tensile data secured from the corroded specimens.

After weighing and inspection the "removable" plate specimens are to be returned to the various test locations for further exposure. In transporting the plate specimens back and forth from the test locations they will be shipped in specially designed containers to ensure minimum damage to the corrosion films formed on the surface of the specimens. To make sure of the exact identity of each plate and tensile specimen, a number was stamped on each one with steel dies. With the assistance of printed forms a record was made of the exact position of each specimen in the individual specimen racks which are identified by numbered brass tags attached to them.

EXPOSURE RACKS.

Since the atmospheric corrosion tests may continue for twenty-five years, it was necessary to select a fairly permanent type of construction for the specimen racks and supporting structure. The individual specimen racks and the main framework on which they are mounted were therefore built of structural steel protected by a heavy coating of zinc applied by the hot-dip galvanising process. All fittings, nuts, bolts, &c., used in assembling the test racks were likewise hot-dip galvanised. The vertical members of the main supporting framework were buried in the ground with substantial footings of concrete to afford a suitable foundation and earth anchorage.

At seven of the nine test locations the test racks are in enclosures protected from disturbance by high wire fences. The other two locations are roofs of industrial buildings in Altoona, Pa., and New York City.

Test Locations.—In selecting locations for the exposure tests an effort was made to secure a wide variety of atmospheric conditions which, at the same time, would be fairly representative of the atmospheres in which the metals and alloys included in these tests are used in large percentages. The types of atmosphere included in the nine test locations can be broadly classified as industrial, rural, and sea coast. There is considerable variation between the atmospheric conditions at the individual locations included in any one of the foregoing groups, and therefore these general classifications have only a broad significance. It is also appreciated that the severity of the atmospheric attack will vary considerably even within the immediate neighbourhood of a test location. Differences in elevation, variations in exposure to prevailing air currents, and the amount of atmospheric pollution in the form of industrial gases can all be found to vary widely between two locations only half a mile apart. It is essential that these facts should be clearly kept in mind in interpreting and using the corrosion data resulting from these tests.

Liquid Corrosion.—Data and information on the resistance of representative metals to a few common solutions are being sought by means of field tests that are being carried out under the actual conditions existing in practice. Metal specimens are being exposed within various kinds of equipment, such as evaporators and tanks that are in actual operation handling corrosive liquids. The specimens are being immersed in solutions of sulphuric acid, hydrochloric acid, caustic soda, and common salt. At each location three lots of specimens are to be exposed successively for periods of time that will be increased progressively. Twenty-two different metals are included in the current tests, but every metal is not being tested against every corrosive.

Galvanic and Electrolytic Corrosion.—The corrosion testing programme on galvanic and electrolytic corrosion includes outdoor exposure tests at nine locations of galvanic couples of the metals in common use and complete immersion couple tests of certain metals and alloys in hot water, brine alkali, and acid. Couple combinations of all of the following metals are being subjected to outdoor exposure:—Aluminium, copper, mild steel, tin, zinc, nickel, and lead.

Four sets of couples have been exposed in each of the nine test locations listed above, where atmospheric corrosion tests are in progress.

In the immersion tests the couples consist of a standard tension test specimen of one metal or alloy coupled with a similar specimen of another metal or alloy. Couple combinations of those metals which have generally been used commercially under exposure conditions similar to test conditions are included in four liquids. These are sea water, sodium hydroxide, hot water, and sulphuric acid. The data which will result from these tests will be used to recommend metal combinations which can safely be used in the four types of exposure without serious galvanic couple action occurring.

In its annual report to the Society, the Committee included detailed descriptions of a recommended practice for the carrying out of each of several laboratory accelerated tests now in use. A critical discussion of each test was also given. Descriptions of laboratory accelerated tests sometimes make it appear a little too certain that by the exercise of some care a particular type of test can be conducted under conditions which permit interpretation in terms of actual service. General experience teaches that it is very difficult to establish and control the conditions of test so that a parallelism exists with a particular type of service. Producers are trying to make materials which will stand up in service rather than in laboratory tests. Too many people try to find out what will make a good condenser tube, for example, by hanging samples from a dock, or what will make a good roofing material by immersing samples in an acid solution in a laboratory beaker.

SEARCH is being made off the coast of Delaware for the wreck of the British war vessel "Debraake," which was sunk about 100 years ago with some £2,000,000 in gold aboard.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Situation.

THOUGH little further headway towards trade recovery has been made during the past week in Midland and Staffordshire industries, at least there has been no retrograde movement. Some industrialists in various branches of trade hold the firm opinion that business is on the mend, though they do not furnish any proof of industrial expansion. There are signs of returning confidence, and there are few who doubt that trade will broaden and develop during the next few months. Iron and steelmasters are hopeful and the tone of the Birmingham market this week was far from depressed. There was a reasonably good attendance on 'Change and an encouraging note was struck in many conversations. Manufacturers really believe that they will require more iron and steel to meet their needs to the end of the year than they have had need of during the quarter now drawing to an end.

Pig Iron.

Seasonal trade is responsible for a little more movement in the pig iron market this week, so that, though very slowly, progress continues to be made. The relighting of a blast-furnace at Netherton, near Dudley, is regarded as a sign of growing confidence, but it has no significant bearing on the Midland pig iron market, since the furnace concerned is understood to be producing cold blast iron used for special purposes. Nevertheless, for the firm to have made such a move with the outlook admittedly obscure, gives cause for congratulation and encouragement. District foundries are doing rather better than they were and producers of light castings are taking reasonably good deliveries of foundry iron. Demand from the engineering foundries remains fitful and unsatisfactory. In the consuming industries there is, generally speaking, a disposition to buy only for known needs, and few new contracts are being entered into. Specifications against existing contracts are satisfactory in so far that they come up to users' estimated rates of consumption. Stocks of iron at the furnaces in this area are heavy and do not appear to be lessening. Current output, moreover, is, if anything, above the needs of the market. The superabundance of good scrap iron at a low price is affecting pig iron sales. Normally, there is only a moderate field for the use of forge iron, and in the present depression there is very little of this grade being bought. Association prices are being quoted for No. 3 foundry iron at £3 2s. 6d. for Northamptonshire, and £3 6s. for Derbyshire. Forge iron costs £2 17s. 6d. for Northamptonshire, and £3 1s. for Derbyshire. These prices are for delivery at stations in the Black Country and are subject to rebate according to the quality ordered.

Blast-furnace Relighted.

One of the blast-furnaces at the works of M. and W. Grazebrook, Ltd., ironfounders, Dudley, was relighted last week after being out of commission since February. It will find employment for fifty to sixty men. The furnace is being restarted in the hope that trade is going to improve and in order to find work for men who have been unemployed so long. "There is at the present very little improvement in the pig iron trade," a representative of the firm said, "and we are restarting on expectations of orders rather than on orders we have booked. But we felt something ought to be done for our men, and we sincerely hope we may be able to carry on."

Steel.

There has been no movement of note during the week in the position of the finished steel market, or of the heavy steel situation generally. Works continue to operate on restricted programmes. The constructional engineering trade continues very quiet, and there is little or no demand from railways and municipalities. Mills which roll joists and plates are in a better position than those concerned with sections. The explanation given is that the smaller constructional jobs in which section steel is principally used are not being put in hand owing to continued financial stringency. There is not a steady output of joists and plates; nevertheless, operations are less cramped than in the other departments. Association selling prices are rigidly adhered to. Local steelmakers report that they have sold some fairly good tonnages of sheet bars this month. This is a little more cheerful news, and is the only new feature which has developed in the semis branch of the market. Continental prices show a slight reaction from the high level touched last week. Quotations for billets and small steel bars are about 1s. easier, and this change can be attributed to exchange fluctuations. English billets are quoted at £4 17s. 6d. for large quantities, with a graduated scale up to £5 7s. 6d. for small lots. The local re-rollers quote £6 7s. 6d. for bars rolled from imported billets. The position of the steel scrap market is a little more hopeful following a slight upward move in prices, but demand is still very slow.

Finished Iron.

There is a general shortage of orders for all grades of finished iron, and works in Staffordshire are only operating about three days a week. The position calls for a great deal of improvement. Orders are of small content and are placed from day to day, the consuming industries not being in a position to gauge their requirements over an extended period. General engineering firms in some instances take a more favourable view of the outlook than has been the case of recent months, and some of them express a belief that they will be large buyers of finished iron in the near future than they have been of late. Ironmasters sincerely hope that such will prove to be the case. They personally endeavour to look upon prospects as improving, but there is little tangible evidence available as yet. Inactivity is the rule rather than the exception. Selling prices of best grade iron are firmly held at £12 per ton at makers' works, producers being of the opinion that no useful purpose would be served at the moment by any price readjustment. Values in the Crown bar department are irregular and weak. Competition for the small amount of business which comes on to the market is very keen, and local makers are outbidden by those from other manufacturing areas. Selling prices range from just below £9 per ton to £9 15s., according to grade. Only small quantities of Staffordshire common bars are being disposed of, the consuming industries in the Black Country having stocks of cheap foreign material still to use up. Local fencing and nut and bolt iron ranges from £7 15s. to £8 5s., while competitive Belgian iron is on offer at a little over £6 per ton delivered. Iron tube strip is held for £10 7s. 6d. per ton. Demand is at best moderate, and mills could do with considerably greater support.

Galvanised Sheets.

Improved demand for galvanised sheets from overseas buyers has enabled local millowners to secure more remunerative terms. Selling prices have appreciated a further half-a-crown per ton, bringing them to the basis of £9 10s. for galvanised corrugated sheets of 24 gauge. A few weeks ago there were reported to be some substantial inquiries in circulation and it would appear that some at least of them have now materialised. A number of useful orders have been received from abroad by district mills, and further inquiries encourage hope of additional business in the near future. There are said to be signs of weakening in the spelter market, and should this movement bring about a drop in selling prices, values of galvanised sheets may decline proportionately. On the other hand, recent production has been disposed of at such low figures that makers of sheets are bound to use every endeavour to keep up the present selling figure. Work is a little more even at the mills this week, but there is no reserve of orders and the position needs consolidating before there can be any certainty as to the future. The call for sheets for the home market is hardly so good as of late, new orders being difficult to obtain. Black sheets are in moderately good request and values remain firm and unchanged.

Steel Arches in Mines.

Dealing with the question of ventilation of mines in his annual report on conditions in the coal mines in the Midlands, Mr. W. E. T. Hartley, the Inspector, states that "in general the ventilation of the mines in the division is well carried out, and the great increase in the use of steel arched girders is having a marked effect on the quantity of air passed into the faces. At one colliery where steel arches have replaced props and bars in the main roads, it has been possible to reduce the water gauge at the fan by one-third, and at the same time to increase the quantity of air at the face. As the fan runs continuously throughout the year, the saving in power is considerable. Mr. J. R. Felton, the Inspector for the North Midland division, in his report, also emphasises the advantages of steel arches for supporting underground workings, and states that although progress is being made in this direction it is not so rapid as he would desire.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Textile Machinery Exports.

ALTHOUGH textile machinery exports last month were slightly higher in value and appreciably higher in quantity, than they were in the corresponding period of last year, they failed to reach the average, from the point of view of both quantity and value, of the previous seven months of this year. The shipments during the period under review amounted to 4387 tons and £388,728, compared with 3309 tons and £344,000 in August, 1931. Last month's exports included 2993 tons of spinning and twisting machinery and 985 tons of weaving machinery, the respective values being £269,195 and £72,872. To all the principal markets except four—British India, China, Australia, and Russia—the value of exports was on a lower level than a year ago. British India was easily the leading market, with shipments valued at £109,213. China came a poor second, with £46,681, followed by South America, £31,099; Australia, £23,074; Japan, £16,866; France, £15,109; Germany, £14,475; the Netherlands, £10,333; Russia, £5486; and the United States, £4839. Shipments to "other European countries" reached an aggregate value of £82,728. During the January–August period of this year textile machinery exports amounted to 43,750 tons, valued at £3,813,876, compared with 33,625 tons and £3,426,691 in the first eight months of 1931.

Awaiting a Settlement.

Engineers and the iron and steel and heavy trades generally in this part of the country are anxiously awaiting a settlement of the dispute in the Lancashire cotton industry, for the reactions of the stoppage are being felt over a wide range of industries. Textile machinery manufacturers and many jobbing foundries which depend primarily upon cotton mill work are already feeling the effects, and there have been reports during the past week of interference with output at certain collieries in the district, directly or indirectly in consequence of the strike. Representatives from both sides of the cotton industry have been negotiating in Manchester for more than a week, and obstacle after obstacle has been overcome. Hope has been freely expressed that a settlement would be arrived at this week-end, but one or two of the most formidable obstacles have yet to be surmounted, and the maximum of tact and understanding will be needed on both sides if the goal is to be reached.

Non-ferrous Metals.

Following upon last week's very severe loss in all sections of the non-ferrous metals market there has been a general recovery this week, although the ground regained has represented but a small part of the losses. Under the influence of outside factors, chiefly political in character, the market has displayed a good deal of nervousness and uncertainty. At times selling movements by speculative interests have had a depressing effect on prices, but in some instances substantial recoveries were effected, although the best values of the week have not been maintained. The immediate outlook, from the point of view of prices, is decidedly obscure, and at the moment users of the metals, as distinct from the speculative element, are inclined to move cautiously. In the case of tin, the turnover has been on a moderate scale, with quotations higher on balance by about £2 per ton, compared with a loss of £10 or thereabouts in the previous week. Stocks of the metal in London and Liverpool last week end showed a slight contraction. Standard brands of copper are dearer on the week to the extent of just short of £1 10s. per ton, but buying interest in this section of the market has been somewhat less active than in recent weeks. There has been a moderate demand about for lead, with values about 5s. per ton higher. This has also been the extent of the rise in the spelter section; inquiry for this metal from industrial consumers in this country has been rather quieter.

Iron and Steel.

There is still an absence of much in the way of favourable development on the iron and steel markets here. Relatively speaking, the light castings trade is about the best situated branch of the Lancashire foundry industry, although with the approach of the quieter season, business, even here, is expected to show some contraction. In most other directions, and especially in the textile machinery industry and among general founders, order books are generally poor. Foundry iron sellers on this market report a readiness on the part of users to order additional quantities where contracts are expiring, but in most cases there is little disposition at the moment to buy more than is sufficient to meet requirements over about a month. The superabundance of machinery scrap is, of course, a factor of importance in the market for pig iron. Foundry iron prices for delivery to users in the Manchester district are on the basis of 67s. per ton for Staffordshire, Derbyshire, and Cleveland brands of No. 3, 65s. 6d. for Northamptonshire, 62s. for Derbyshire forge, from 84s. to 84s. 6d. for Scottish foundry, and about 81s. for West Coast hematite. Indian iron for delivery equal to Manchester ranges from about 67s. to 74s. per ton, according to grade. Bar iron prices are steady at £9 15s. per ton for Lancashire Crown bars and £10 5s. for best quality material. At the moment inquiry for both iron and steel forgings is very moderate. Additional work has come the way of structural engineers, but new inquiry that is being dealt with relates to comparatively small jobs. From this, as from most other directions, current steel buying is on a strictly early delivery basis, and there is still no disposition for users to enter into forward contracts. Acid and basis quality boiler plates are quoted at round £8 10s. per ton, with tank plates at £8 17s. 6d., sections at £8 7s. 6d., joists at £8 15s., large diameter bars at £9 7s. 6d., and small re-rolled sorts at from £6 15s. to £7. There is a growing expectation locally that a higher tariff will be placed in the near future on imported iron and steel products, and, as there was earlier in the year, there is a readier disposition among users to place orders, always providing that the sellers will shoulder the risk of any extra duty. This, however, the latter are not willing to do. In the meantime, the price tendency of most descriptions of Continental products offered on this market is steady.

BARROW-IN-FURNESS.

Hematite.

The market continues to be quiet, and the output is still restricted. Until stocks are reduced at the various works there will be no increase of make. In some quarters there is a feeling that things will improve in the next month or two, but at the moment the signs are not noticeable to any extent. Neither America nor the Continent has come into the market yet, while the home demand is strictly limited to immediate requirements. The iron ore trade is very dull and likely to be until there is a general improvement in the iron trade. The furnace at Backbarrow, which is exclusively engaged on the making of special iron, has got to work again after being overhauled and having new charging gear installed. The steel market continues to be very quiet, and there is little promise of activity at the moment. The rail mills at Barrow have not got to work again, but there are hopes that they may restart in the early future. Shipping continues to be dull. Shipbuilding is quiet, and engineers are moderately employed. There are about 9000 employed at Vickers-Armstrongs Naval Construction Works at Barrow at present.

SHEFFIELD.

(From our own Correspondent.)

More Confidence.

WHILST there has been no important tangible development during the week, a more confident tone prevails in local industry and is particularly manifesting itself in the lighter branches. This is confirmed by the fact that more electric current is being consumed in Sheffield factories than was the case a year ago. A considerable amount of new work has been obtained by Vickers, and, what is more, there is a likelihood of continued expansion. In the heavy steel and engineering branches there is a good deal of short-time working. Orders from constructional and mechanical engineers and shipbuilders are very scarce, but motor requirements, although not so large as last year, continue to provide a large amount of work for many firms in the city. The reference by the chairman of the Sheffield Forge and Rolling Mills to the prevalence of small orders may be applied to nearly every section of trade, which is at present doing little more than supplying hand-to-mouth needs. The market for steel-making ferro-alloys has been a little more active, notably as regards ferro-silicon and ferro-chrome, but tungsten continues to be neglected.

Irish Trade.

Sheffield trade with the Irish Free State is nearly at a standstill as a result of the new tariffs, but the present conditions are regarded as temporary and some revival of buying is expected before long. The Free State is normally one of our best overseas markets. The financial dispute with the British Government has had the effect of reducing the purchasing power of the Free State, which, however, judging by the August returns, still holds its position as the largest overseas customer for British motor cars.

Railway Work.

Orders from the home railways for tires, axles, and springs have improved recently, and Sheffield is expecting to benefit as a result of the closing down of the L.M.S. steel works at Crewe, about which further details are to hand. The melting plant there was enlarged and modernised a few years ago, but the rail and tire mills are out of date, and it would require heavy capital expenditure to replace them with mills which could produce as cheaply as those of the private firms. The material hitherto produced at Crewe will for the future be supplied by private firms.

Tariff Benefits.

Whatever may be the ultimate outcome of Britain's tariff policy, the benefits of it to Sheffield industry are showing themselves in various branches. Mr. S. C. Goodwin, the chairman of the Neepsend Steel and Tool Corporation, Ltd., the other day announced that since the beginning of the present financial year they had benefited by the tariffs, which had enabled them to increase the number of their workpeople and increase their wage bill, which, for the last few weeks, had been higher than for a good many years. In a recent visit to the Continent, on business, he had, he continued, investigated the wages of men engaged on work similar to their own, and in all cases they in Sheffield paid more for a fortnight's work than manufacturers on the Continent paid for a month's work.

Gas-fired Boiler for Brass Work.

Experiments with the object of interesting brass manufacturers in the use of gas have just been carried out in Rotherham. Hitherto the difference between the price of gas and coke used in the trade has not been sufficient to cause brass manufacturers to consider gas with any degree of seriousness, but by means of a new type of furnace which has been introduced by Armstrong, Whitworth, Ltd., it is claimed that the cost of heating by gas has been reduced considerably, and, by arrangement with the Rotherham Corporation Gas Department and the College of Technology, demonstrations showing the capacity of the furnace and of the efficiency of gas in one of Rotherham's most important industries have been made possible. Metal for treatment has been supplied by local firms and the possibilities of gas in the brass trade have been demonstrated. Not long ago the question of using gas for the propulsion of omnibuses was under consideration at Rotherham, and joint steps were taken by the Gas and Transport Departments to explore the possibilities of gas as an alternative to petrol. When the Ministry of Transport's sanction has been obtained Rotherham will put the results of the research to practical use.

File Cutting.

There is being laid down in one of the East End works a new file cutting machine which is arousing a large amount of interest in the trade. The new machine is represented as working on the rotary principle by scooping out the teeth instead of by cutting by the down stroke of a chisel. Great claims for its possibilities are made and developments are awaited with much interest.

Staveley Company's Improvements.

The Staveley Coal and Iron Company, Ltd., in order to improve the quality of its bleaching powder and the conditions of the workmen employed on this product, has just completed a new installation on a thoroughly up-to-date plan. A plant for the manufacture of blacking for use in the company's foundries has also been erected.

Rotherham Gas Price "Revolution."

The manager and engineer of the Rotherham Corporation Gas Department has submitted to the Borough Council a scheme which will permit of gas being supplied to householders at the low price of 10d. per 1000 cubic feet. The present price in Rotherham to householders is 3s. per 1000 cubic feet. It is the first gas-selling municipality to apply successfully an experiment, the principle of which has been known for some years to gas engineers, though Rotherham's method of applying it is entirely new to the industry. With the new low price a small gas fire will cost only ½d. per hour, and all the hot water required for the house can be had for about 1d. a day. Gas will thus be cheaper than coal for household use. The tests to which the scheme has been put have satisfied the Department that, in addition to providing cheap gas to domestic consumers, there will be a substantial profit for the Department. Another effect will be the speeding-up the change that is taking place in the domestic fire-place. The development will stimulate interest in the movement for the substitution of gas fires for the old, smoke-producing coal fires, and will help in the solution of the smoke problem. Several large steel and iron firms in the district are converting their furnaces so that gas will take the place of coal for re-heating purposes.

An Old Cutlery Firm.

The goodwill, trade marks, and patterns of John Nowill and Sons, Ltd., of Scotland-street, Sheffield, have been purchased by Mr. C. F. Nowill and Mr. W. Esmond Nowill, who are descendants of the founder of the firm. This is one of the oldest and best-known cutlery establishments in Sheffield. The Cutlers' Company records that Nowill's D and star mark was registered in the year 1700. A subsequent mark was the device of crossed keys. Ever since the year named the business has been carried on by successive generations of the Nowill family. Nowills have always specialised on cutlery of the best quality, and their activities cover all branches of the trade.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

As is not unusual after a period of brisk buying, the Cleveland pig iron market is quiet, but cessation of operations is expected to be of brief duration. Nevertheless, a more confident feeling is abroad, and there is a general feeling that the corner of the long period of depression has been reached. At all events, inquiries are still circulating fairly freely, and some rather substantial sales are expected to be put through during the next few weeks. Present demand does not warrant the restarting of more plant, but now that the movement in the direction of trade recovery has commenced there is every prospect of operations at the furnaces being increased. There are now seventeen blast-furnaces in operation in this district, six of which are making forge and foundry iron, six basic iron, and five producing hematite. Local consumption of iron promises to expand, and improvement in demand from other home centres seems not unlikely, while deliveries to overseas firms are expected to be better than for some months past. A few sales to Dutch and other overseas customers is an encouraging feature this week. Unfortunately, Scottish consumers cannot be induced to purchase Cleveland iron in bulk, notwithstanding the specially low rates quoted in that area in competition with Indian and other irons. Fixed minimum prices to home consumers are firmly maintained, No. 1 Cleveland pig iron being 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

East Coast hematite pig iron only commands a slow sale for early delivery, but there are consumers who would not be averse to buying ahead at present prices, were makers prepared to enter into long-dated contracts. The general market rate for East Coast mixed numbers is 60s., but in some cases this can be shaded.

Ironmaking Materials.

Consumers of foreign ore are well placed as regards supplies, and sellers are not keen to accept the low prices obtainable. Nominally, market rates are based on best Rubio ore of 50 per cent. quality at 14s. 6d. c.i.f. Tees. With consumption of blast-furnace coke very limited, sellers are still prepared to accept 14s. 6d. for good medium qualities delivered to the works in this district.

Manufactured Iron and Steel.

There is very little change in the manufactured iron and steel trade, orders still being limited to small tonnages for early delivery. Manufacturers, however, are looking forward hopefully to a gradual expansion of business during the autumn months. Prices are firmly maintained.

Naval Work for Tyneside.

The naval contracts which have been placed with two Tyneside firms are very welcome, but there is keen disappointment that no work has been allocated to Jarrow, which is regarded as the most distressed town in the country to-day. R. and W. Hawthorn, Leslie and Co., Ltd., Hebburn, are to build the hulls and machinery for two destroyers, and Swan, Hunter and Wigham Richardson, Ltd., Wallsend-on-Tyne, the hulls of two destroyers. The machinery will be constructed by the Wallsend company. At present the only work in hand at Swan, Hunters is a train ferry steamer, which is being built at the Neptune Yard, Walker. Hawthorn, Leslie and Co. have under construction a Portuguese sloop, which is shortly to be launched; another, which is being fitted out, and a big reconditioning contract on the s.s. "Akarva," belonging to the Shaw Savill Company.

The Coal Trade.

Prospects in the Northern coal trade have improved appreciably. Some additional cargoes of coal and also coke nuts have been secured for shipment to Canada, and more business is under close negotiation. Shippers, however, find tonnage difficult to attract, as so many boats have proceeded or are proceeding to the St. Lawrence in ballast. The limited tonnage on offer and the advance in freights tend to check shipments, and many contractors are unable to take out full volume of commitments through the difficulty of securing tonnage. Pits are working irregularly in several districts, coking coal producers having, perhaps, the quietest time at present. It is likely, however, that there will be less lost time as the winter approaches. Domestic consumption is already on the increase, and tenders will be opened in the next few days in respect of coal required by railway and other undertakings abroad over the last quarter of the year. There are expectations of some portion of the orders coming to this district. New business in the Northumberland steam coal trade is coming forward slowly, but as collieries are already well booked for this month and not forcing the market ahead, the undertone is fully steady. Prompt lots are not excessive. Forward Northumberland best steams are firmly indicated at 13s. 6d., with prime Wear at 15s. to 15s. 1¼d. Tyne primes are unchanged, but steady, at 12s. 9d., and other grades rule at 12s. to 12s. 6d. Northumberland best steam smalls are in demand, and firmly quoted at 8s. 6d., while Tyne best small are steady at 9s. and good ordinary at 8s. Prime Wear smalls

are well taken up and steady at 11s. to 11s. 1½d. There is no great pressure for Durham gas coal, but under more favourable bookings for the next week or two and a fairly substantial inquiry, fully steady prices are asked. Best qualities are 14s. 6d. and secondary 13s. to 13s. 6d. There is a better demand for bunker coal for shipment this month to Mediterranean coaling stations, also for the West Indies, but this is counterbalanced by the limited requirements for vessels calling to replenish individual stocks. Sellers offer all brands freely, best at 13s. 6d. to 13s. 9d., and seconds at 13s. Durham coking unscreened are quiet, but on the whole show a steady tendency at 12s. 6d. to 13s. 3d. Gas coke continues in excellent demand, but makers are practically sold out, and contractors have only odd lots to offer. Best gas coke is firm at 17s. 6d. Patent oven coke is steady at 14s. 6d., with superior makes at 16s. 6d. Coke nuts are in increased demand, quoting firmly at 16s. to 18s.

SCOTLAND.

(From our own Correspondent.)

Position Unchanged.

THE industrial position in Scotland is practically unchanged, though inquiries in circulation would appear to indicate a seasonal interest in certain markets. Interest in the West of Scotland centres to a considerable extent on the position at the shipyards, and particularly in the efforts being made to restart the work on the Cunarder at Clydebank. It is thought that a restart on that vessel would lead to the placing of other orders for tonnage and thereby greatly assist in stimulating interest in allied industries.

Steel.

Home demands for shipbuilding, engineering, and structural purposes are on a modest scale at present. Plate and section mills are irregularly operated. On the other hand, export inquiries for black sheets are expanding, latest advices indicating considerable quantities having arrived from South America, India, and the Far East. Light sheets are the chief demand, heavy descriptions and galvanised sheets being slow to revive. There is a little more inquiry for tubes, owing partly to the postponement of the Australian tariffs until December 1st.

Iron.

Business in bar iron is not opening up to any extent, but there are prospects of improvement in re-rolled steel bars, some markets which have been dormant for a considerable period having begun to show some interest. Re-rolled steel bars are quoted £6 10s. home and £6 5s. per ton export.

Pig Iron.

The reduction in the price of pig iron has not produced any extra business so far, and demands are easily met from makers' stocks. During the week 1700 tons of pig iron arrived in this district from Calcutta.

Scrap.

The tendency of scrap is still in a downward direction, heavy steel being now quoted 34s. and cast iron machinery 44s. 6d. per ton.

Coal.

Home and export demands for Scottish fuel are not sufficient to absorb supplies of round coal, with the possible exception of best Fifeshire steams. Last week a cargo of 500 tons left Ayrshire for Southern Ireland, this being the first shipment since the Free State tariffs became operative. There is, however, no indication that this means a restart of shipments, which, as a rule, aggregated about 150,000 tons per annum. Washed nuts, especially Fifeshire sorts, constitute the firm spot in the market, with the scarcity of trebles the outstanding feature. Aggregate shipments amounted to 220,471 tons, against 231,534 tons in the preceding week, and 200,581 tons in the same week last year. Tenders have been wired to the Swedish State Railway authorities for the shipment of 37,000 tons of fuel for locomotive purposes to be delivered at southern ports during October, November, December.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

THE returns issued by the Customs show that coal exports from South Wales for the month of August were the lowest for any month this year since April. The total for August was 1,339,343 tons, which compares with 1,478,029 tons for the preceding month. There is a fair prospect that the figures for the current month will display some improvement upon those for August, notwithstanding the fact that tonnage at the disposal of the collieries has been much below their requirements and business to all appearances has been very slack. The figures issued by the Great Western Railway Company for last week are certainly encouraging, as the statistics of coal and coke shipments for the six ports in this Channel under the company's control show that the quantity was 416,940 tons, as compared with 359,730 tons for the preceding week and with 426,663 tons for the corresponding period of last year. At the end of last week the returns showed that no less than forty-one tips were idle at the various ports, of which thirty-nine were at the steam coal loading ports, while at Swansea two tips were idle, though there were three steamers waiting to berth. This week has opened fairly well, as the number of idle tips on Monday was reduced to twenty-two, while it is notable that at Swansea all berths were filled and there were no less than six vessels waiting which indicates that the loading pressure for anthracite coals is heavy. As might be expected in the case of steam coals, the news is of a somewhat mixed character. One bright feature is the fact that recently there has been a better demand for bunker coals, and it is refreshing to find that as the result of an improvement in the homeward freight market, principally for grain carriers from Canada, and to a lesser extent from the River Plate, quite a number of steamers which have been laid up have again been put into commission. This is all to the good, as the more tonnage is running the better will be the demand, both at home and abroad, for bunker coals. One item of interest about which, however, no official news has been forthcoming is the disclosure of the fact that international conversations relative to the production and disposal of coal and patent fuel took place in the early part of this month, when representatives from this country and all the leading Continental countries met at Deauville. It will be recalled that a similar conference took place in London last year. So far as can be ascertained, however, the recent conference at Deauville was productive of no agreement, though no doubt the conversations which took place served some good purpose.

Coal Quotas and Barriers.

Reference was made recently to the proposal of the French Government to bring into operation as from the end of this month certain new conditions by which a larger amount of French-owned tonnage was to be employed in the carriage of coals shipped to France. Nothing further of an official nature has come to hand, but there is a fresh report current in coal trade circles relative to a new basis also being established with respect to the quota for coal imports from the United Kingdom. So far as can be ascertained no official news on this point is to hand, but it is nevertheless very disturbing, as it does not promise to be of advantage to the coal-exporting interests of this country. As is well known, the three years 1928–30 form the basis period now in operation and permitted imports are 60 per cent. of the monthly average quantity for that period, plus 10 per cent. set apart for special allocations. The report now is that the French Government intends to adopt the year 1930 only as the basis period to apply to British coals, and that the actual datum quantity will be arrived at by deducting a certain percentage, which is stated to be about 14 per cent. Having made the deduction of 14 per cent. from the actual average monthly imports in 1930, licences will then be issued for a certain percentage of the balance, but it is not known what this percentage will be, and an uneasy feeling prevails that it is likely to be detrimental rather than advantageous to this country, particularly as it is understood that the French Government intends to stipulate that a certain proportion of the coals taken shall be shipped in French vessels. Another matter of interest to South Wales is the fact that Spanish coalowners have been agitating for a reduction of imported coals, and, as is well known, the Spanish Government has for some time past compelled the railways, public services, and industries to use varying percentages of native coal, resulting in reduced exports of coal from South Wales. Now it is reported that experiments are to be made in order to ascertain whether Asturian coal can be utilised in the Spanish Navy while briquettes are also to be manufactured from small coals and supplied to the Spanish merchant fleet. If these experiments are successful then the use of this kind of fuel will be made compulsory in the mercantile marine. It is true that the Spanish Government does not buy heavy quantities of coal for the Spanish Navy. Nevertheless, several cargoes are taken from South Wales in the course of the year and the possible loss of these orders and others for bunker coals for vessels of the Spanish mercantile marine is not to be regarded lightly.

Miscellaneous Items.

The decision was reached by the Cardiff Court of Referees at the end of last week that Cardiff coal trimmers "stood off" and not participating in the wages pool are entitled to unemployment benefit. The application was made on behalf of trimmers employed at the Cardiff East and West Docks, where 150 of the 196 men comprising the section have been affected owing to the depression in the coal export trade. Up to November last the trimmers regularly drew unemployment benefit, but from that time it was discontinued on the ground that the men, whether working or not, secured their share of the pooled earnings and in these circumstances were "not genuinely seeking work." At a meeting of the "Back-to-Coal" movement held at Cardiff at the end of last week a delegation was appointed to meet the Minister of Mines (Mr. Isaac Foot) on the afternoon of Friday, the 23rd inst. This deputation will, on the morning of the same day, meet the Welsh members of Parliament to decide upon the course of action to be followed at the meeting with the Minister. At the same meeting the Lord Mayor of Cardiff was asked to bring before the City Council the question of utilising gas-propelled vehicles and railless electric omnibuses so that Cardiff may give a lead in the matter. Efforts are being made to avoid the real prospect of the Llanharry Iron Ore Mines being closed down permanently. A petition has been sent to the Prime Minister, Mr. Stanley Baldwin, and Mr. Isaac Foot (Minister of Mines), drawing attention to the disastrous consequences to the district and asking the Government to utilise the machinery which it has at its disposal in fixing a quota for the Llanharry Mines. For a long time past these mines have been working on short time. Efforts have been made from time to time to attract new industries to this part of the country, and it will be recalled that not long ago a new Regional Industrial Development Council was formed for South Wales. It is now reported that twenty-three local authorities have agreed to join the Council and contribute according to their standing. The total sum promised to date is £1564. Replies, however, have not been received from fifteen authorities, including the Glamorgan and Monmouthshire County Councils, while Swansea, Neath and Port Talbot have withheld their support from the movement.

Current Business.

Generally speaking, new business is quiet on the steam coal market, though there is a slightly better tone. Some improvement is looked for at this season of the year. Among inquiries on the market is one from the Riga Municipality for 46,000 metric tons of coal for delivery between October and January, while the Greek Railways are in the market for six cargoes of 5000 tons each, coal or patent fuel, for shipment before April next. Coal prices have not undergone any material change, though sized descriptions of dry coals maintain their firmness and command 6d. to 1s. above the schedule. Coke moves off slightly better and patent fuel is steady, but pitwood displays no improvement.

LAUNCHES AND TRIAL TRIPS.

HARTLEPOOL, steamship; built by Wm. Gray and Co., Ltd., to the order of J. and C. Harrison, Ltd., London; dimensions, 441ft. 8in. by 56ft. 3in. by 28ft. 9in.; to carry cargo. Engines, high-pressure balanced quadruple-expansion type; pressure, 260 lb. per square inch; constructed by the builders; trial trip, Wednesday, September 14th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

EDWARD G. HERBERT, Ltd., Manchester, has entered into an agreement with the Tinius Olsen Testing Machine Company, of Philadelphia, Pa., U.S.A., to manufacture under licence at Levenshulme, the range of Olsen-Lundgren static-dynamic balancing machines for balancing crank shafts, fly-wheels, armatures, rotors, &c. The firm has acted as sole agents in Great Britain and Ireland for Messrs. Olsen for the last twenty-five years. Henceforward, every component of the Olsen-Lundgren machines manufactured here will be entirely British.

MR. W. A. SYCAMORE, who, since 1926, has held the position of sales manager with A. G. Mumford, Ltd., and later their associated company, John Kirkaldy, Ltd., has joined the sales organisation of Davey, Paxman and Co. (Colchester), Ltd. (which company has recently purchased the old-established business of Davey, Paxman and Co., Ltd.), and will be attached to their head office and works at Colchester.

CONTRACTS.

THE PULSOMETER ENGINEERING COMPANY, Ltd., Reading, has received an order from the Hadleigh Urban District Council for supplying three sets of crude oil engines and centrifugal pumps (supply, erection and fitting), two of which are to be provided with automatic starting and stopping switchgear at the pumping station.

H. TOLLEMACHE AND CO., Ltd., of Canada House, Norfolk-street, London, W.C.2, have received a repeat order from the Carlton Main Colliery Company, Ltd., for the conversion of a further eight Lancashire boilers at Grimethorpe Colliery from hand to pulverised coal-firing. This installation, when completed, will be the largest Lancashire boiler plant in the world operated by pulverised coal.

CATALOGUES.

H. TERRY AND SONS, Ltd., Redditch.—New general catalogue and price list.

ALFRED HERBERT, Ltd., Coventry.—Particulars of "Ardalloy," a new high-speed cutting alloy.

JOHN FOWLER AND CO. (LEEDS), Ltd., Leeds.—Publication describing the Diesel gyrotiller.

BUTLER MACHINE TOOL COMPANY, Ltd., Halifax.—Sectional catalogue on spiral electric planers.

ALFRED HERBERT, Ltd., Coventry.—Catalogue Sheet O 702, on all-electric ball bearing drilling machines.

BUTLER MACHINE TOOL COMPANY, Ltd., Halifax.—Sectional catalogue, Sheet 1, on spur gear drive planers.

BAXENDALE AND CO., Ltd., Miller-street, Manchester.—List No. 3218 of electric light and power accessories.

BRISTOL OXYGEN COMPANY, Ltd., Angel-road, N. 18.—Illustrated catalogue of acetylene lighting equipment.

HALL AND PICKLES, Ltd., Port-street, Manchester.—Fourth edition of the firm's "Hydra" tool steel catalogue.

VICKERS, Ltd., Vickers House, London, S.W.1.—A brochure of the Vickers group of companies and their products.

W. C. HOLMES AND CO., Ltd., Huddersfield.—Brochure No. 8 of gas valves and special connections in cast iron and steel.

MUREX WELDING PROCESSES, Ltd., Ferry-lane Works, E.17.—Publication entitled "Arc Welding on Tramways."

LAFARGE ALUMINOUS CEMENT COMPANY, Ltd., 296–302, High Holborn, W.C.1.—"The Characteristics of Ciment Fondu."

FLEMING, BIRKBY AND GOODALL, Ltd., Halifax.—A booklet illustrating and giving particulars of conveyor and elevator belting.

BRUCE PEEBLES AND CO., Ltd., Edinburgh.—Leaflet No. 183, describing a 1000 kW remote-controlled rectifier equipment at Harrow.

THOMAS ROBINSON AND SON, Ltd., Railway Works, Rochdale.—A 200-page illustrated catalogue of all classes of wood-working machinery.

ENGLISH DRILLING EQUIPMENT COMPANY, Ltd., 3, Grosvenor-gardens, S.W.1.—Leaflets giving particulars of "Edeco" portable drilling rigs.

ASHMORE, BENSON, PEASE AND CO., Ltd., Stockton-on-Tees.—Leaflets on coke oven equipment and the McGee thermal expansion goggle valve.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—The following scholarships have been awarded by the Institution of Electrical Engineers for 1932:—Ferranti Scholarship, C. D. J. Statham, B.Eng. (Sheffield University); Duddell Scholarship, P. J. Rattue (Staveley Grammar School); Silvanus Thompson Scholarship, W. E. Arnold (London, Midland and Scottish Railway Company); Swan Memorial Scholarship, G. N. Davison (Sunderland Technical College); David Hughes Scholarship, R. G. Armstrong (University College, London); Salomons Scholarship, J. S. Wright (King's College, London); War Thanksgiving Education and Research Fund (No. 1), G. J. Scoles (University College, London), T. H. Walker (Sheffield University); Thorrowgood Scholarship, B. O. Banks (Metropolitan Railway).

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/6 to 20/-
(1) Spanish	17/- to 22/6
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	14/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 7 6	—
No. 1 Foundry	3 10 0	—
No. 3 Foundry	3 7 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 0 0	3 0 0
No. 1	3 0 6	3 0 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (a) / 4 0 6 (b) / 4 5 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	9 5 0	—
Best Bars	10 5 0	—
Double Best Bars	10 15 0	—
Treble Best Bars	11 5 0	—
LANCS.—		
Crown Bars	9 15 0	—
Best Bars	10 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 0 0 to 9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 0 0 to 8 10 0	—
Gas Tube Strip	10 10 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ⅛in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.)	11 0 0	9 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	6 15 0 to 7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 10 0 to 8 12 6	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	5 15 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 0 0 to 7 5 0	—
Small Re-rolled Bars	6 7 6 to 6 10 0	—
Billets and Sheet Bars	4 17 6 to 5 7 6	—
Galv. Sheets, f.o.b. L'pool	9 10 0	—
(2) Staffordshire Hoops	9 10 0	—
(d) Angles	8 7 6	—
(d) Joists	8 15 0	—
(d) Tees	9 7 6	—
(d) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 7 6 to 8 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	15/6 to 15/9
Block Tin (cash)	149 10 0
„ (three months)	151 5 0
Copper (cash)	32 17 6
„ (three months)	32 17 6
Spanish Lead (cash)	12 13 9
„ „ (three months)	12 17 6
Spelter (cash)	15 5 0
„ (three months)	15 7 6
MANCHESTER—	
Copper, Best Selected Ingots	37 0 0
„ Electrolytic	38 0 0
„ Strong Sheets	68 0 0
„ Tubes (Basis Price), lb.	0 0 10½
Brass Tubes (Basis Price), lb.	0 0 9½
„ Condenser, lb.	0 0 11½
Lead, English	14 15 0
„ Foreign	13 2 6
Spelter	15 7 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/- per lb.	
Ferro Tungsten	1/9 per lb.	
Ferro Chrome, 4 p.c to 6 p.c. carbon	£25 0 0	8/-
„ „ 6 p.c. to 8 p.c.	£24 10 0	7/6
„ „ 8 p.c. to 10 p.c.	£23 5 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£37 0 0	11/-
„ „ „ 1 p.c. carbon	£44 10 0	14/-
„ „ „ 0·70 p.c. carbon	£46 0 0	16/-
„ „ „ carbon free	1/1 per lb.	
Metallic Chromium	2/9 per lb.	
Ferro Manganese (per ton)	£10 15 0 for home	
„ „ „	£9 15 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£13 10 0 scale 5/- per unit	
„ „ 75 p.c.	£19 0 0 scale 6/- per unit	
„ Vanadium	12/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£245 0 0	
Ferro Cobalt	7/9 per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	12/6
„ „ Ell	14/-
„ „ Splint	13/9 to 14/9
„ „ Trebles	13/- to 13/6
„ „ Doubles	11/6
„ „ Singles	10/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	11/6
„ „ Jewel	16/6
„ „ Trebles	14/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	10/3 to 12/6
Screened Navigation	16/6
Trebles	15/6 to 17/-
Doubles	12/- to 13/6
Singles	10/6 to 11/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	11/- to 11/6
Secondary Steam	10/6
Trebles	14/-
Doubles	11/6
Singles	10/-

(8) N.W. COAST— ENGLAND.

Steams	21/-
Household	32/6 to 52/6
Coke	19/- to 22/6
NORTHUMBERLAND—	
Best Steams	13/6
Second Steams	12/3 to 12/6
Steam Smalls	8/6
Unscreened	12/6 to 13/-
Household	27/- to 39/-
DURHAM—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/- to 37/-
Foundry Coke	24/-

SHEFFIELD—	Inland.	
Best Hand-picked Branch	27/- to 28/-	—
South Yorkshire Best	22/- to 24/-	—
Derbyshire Best House	22/- to 23/6	—
Derbyshire Best Brights	18/- to 20/-	—
Screened House Coal	17/- to 18/6	—
Kitchen Coal	16/- to 17/6	—
Best Screened Nuts	16/- to 17/6	—
Small Screened Nuts	15/- to 16/6	—
Yorkshire Hards	17/- to 18/-	—
Derbyshire Hards	17/- to 18/-	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	7/- to 8/6	—
Blast-furnace Coke (Inland)	9/6 to 9/9 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b., 14/6 to 15/6		

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/- to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/-
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/- to 13/6
Ordinary Smalls	11/- to 13/-
Washed Nuts	19/- to 27/-
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/- to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	15/6 to 16/-
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/- to 18/-
Patent Fuel	20/-
Pitwood (ex ship)	19/- to 19/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	36/- to 38/6
Seconds	27/- to 34/-
Red Vein	22/- to 26/6
Machine-made Cobbles	37/6 to 48/6
Nuts	36/6 to 48/6
Beans	28/6 to 32/6
Peas	19/6 to 21/-
Breaker Duff	8/6 to 9/6
Rubbly Culm	11/- to 11/6
Steam Coals:	
Large	20/- to 20/6
Seconds	18/- to 20/-
Smalls	11/6 to 13/-
Cargo Through	16/- to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.h Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate: Joists (minimum), 22/6: Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. (e) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Trade Developments.

THE method of reinforcing protection by partially excluding competitive imports at a time when there is a widening margin between costs in this country and those abroad has had the effect of producing an industrial stalemate, from which there appears to be no escape except by a complete reform in the system of international exchanges. The principle of import quotas may not be fundamentally wrong as a temporary expedient to tide over an abnormal period, but the quotas have proved disastrous because they have been applied indiscriminately in a way to provoke retaliation, and they have served particular interests at the expense of the community. The quotas are directly responsible for the increased living costs. As, however, they cannot be immediately suppressed without causing serious trouble, some other means must be found of removing the condition of industrial stalemate. The engineering trades are doing no foreign business, and they are finding very little activity at home, nor is there much chance of orders being distributed until the national finances are balanced and work can be started upon the programme of public undertakings that will at least provide a fair amount of employment, and create some feeling of confidence. Meanwhile, no immediate industrial improvement can be expected from new treaties of commerce, the negotiations for which are likely to be long and arduous, and manufacturers are therefore turning their attention to the Danube States, where a good deal of propaganda is being carried on. Here, again, there can be no business until the economic structure of Central Europe is established on a sound basis, and the French are particularly anxious, at Stresa and elsewhere, to place bankrupt States on their feet again so that the carrying out of engineering works in those countries will provide employment in France.

Coal.

The present Government has declared itself in favour of gradually abandoning the import quota system so far as this can be done without disturbing the national economy, and the miners fear that this will mean a loosening of the restrictions on coal imports, the more so because Government has authorised the monthly quota of domestic coals to be exceeded by 100,000 tons. They have interviewed the Minister of Public Works in order to point out to him the difficulties under which the colliery industry labours, with the cost of getting coal to bank from thin seams at great depths and the high social charges, and they insist that the import quota system should be strictly enforced. The Minister explained, what the miners already know, that the increased quotas apply to domestic coals which do not affect the home industry, and in view of the growing agitation amongst consumers of industrial fuels, it is certain that the whole matter will have to be dealt with as soon as there are signs of a recovery in trade.

The Pontoise Bridge.

The old railway bridge across the Oise at Pontoise carrying the line from Paris to Dieppe was a simple construction on five stone piers. Three of these were in the river bed, and the foundation of the central pier was found to be weakened by a stream entering the river at that point. The construction was no longer suitable for modern traffic, and the bridge had therefore to be rebuilt, but without interfering with the railway service. That was done by constructions of timber piers and falsework on each side of the existing bridge, upon one of which the new bridge was built, and then pushed into the place of the old bridge, this being at the same time moved on to the timber piers on the other side, where it would be dismantled. The length of the bridge is 110 m. The new construction is of the bowstring type and its weight is 1800 tons. The old bridge was raised off the piers by jacks to allow of seven lateral roller tracks being laid the whole width of the timber piers, and the new bridge was built on these tracks. At the same time a small temporary bridge carried the signal wires, electric cables and other mains, so that when it was required to place the new bridge in position nothing remained to be done but to remove the end rails on the old bridge. This operation was carried out last week, when the two bridges were displaced 15 m. in ten hours, during which time the traffic was maintained by means of motor cars. At each end of the lateral roller tracks was a winding gear with steel cable and more than 100 men were at work on these gears, which had to be manipulated with great precision under verbal orders of engineers who were partly guided by illuminated signals. These were lamps that were switched in by the slightest deviation from the straight line. The new bridge was brought up for a distance of about 6in. against the old bridge, which it pushed away on to the timber piers, and the new bridge was in place and the first locomotive passed over it well within the allotted time.

Railway Catastrophe.

The accident near Tlemcen, on the Algerian Railway, to a train carrying troops and material to Morocco, when sixty-one men are known to have been killed, twenty-seven are missing and more than 220 were injured, is reported to have been caused by a partial removal of ballast while the line was undergoing repair. At that point the railway skirts the side of a mountain and winds through tunnels and over ravines, and at a curve the train, consisting of fourteen coaches and seventeen trucks, slowed down, it is said, to within ten miles an hour. The driver felt that the rails were slipping and he applied the brakes, when the line shifted and the train fell down a ravine for a distance of about 100ft. At first it was stated that the permanent way had been undermined by rains, but there appears to be little reason for doubting that it had, in fact, been weakened by the removal of ballast during repairs. Moreover, it is asserted that the arrival of the troop train was unexpected, and its weight may have been a contributory cause of the disaster.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

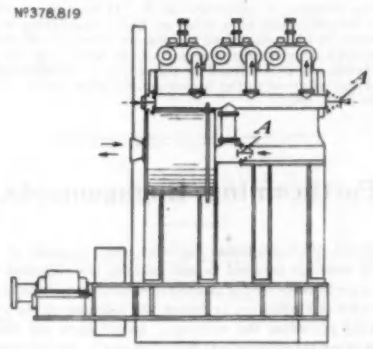
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

378,819. March 12th, 1932.—REVERSIBLE SUPERCHARGED ENGINES, Aktiengesellschaft Brown Boveri et Cie., Baden, Switzerland.

It is desired to simplify the manœuvring of a four-stroke supercharged engine. The supercharging is effected by a Roots blower, which must, of course, reverse with the engine. If the

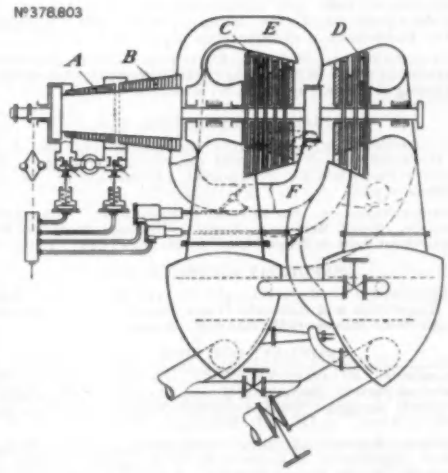


engine were to be supercharged during reversal it would require the manipulation of at least two valves, so on these occasions supercharging is sacrificed, as those occasions are not of long duration. The Roots blower is then allowed to suck air through its normal delivery, through the non-return valves A A, but these valves are made large enough to pass also the air necessary for combustion in the engine.—*August 18th*, 1932.

TURBINE MACHINERY.

378,803. February 24th, 1932.—OVERLOAD STEAM TURBINES, E. Brown, Bahnhofweg 8, Baden, Switzerland.

The inventor suggests that this machine will take overloads of double, or more, the normal rating. It comprises four sections: High-pressure, A; intermediate, B; low-pressure, C, and auxiliary low-pressure, D. C and D work in parallel to carry overloads and high-pressure steam is admitted to the inter-

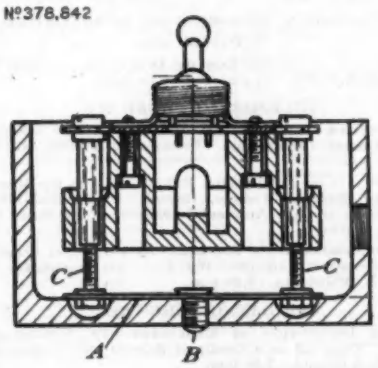


mediate. The exhaust from B then branches through the connections E and F to C and D respectively. For normal loads the auxiliary turbine is cut out and runs in a vacuum to reduce windage. There are two condensers, one for normal working and both for overloads. Valves are arranged in the exhaust pipes to provide for the change. They, and the steam admission valves, are all operated by servo-motors controlled by the governor.—*August 18th*, 1932.

SWITCHGEAR.

378,842. May 8th, 1931.—MOUNTING SWITCHES IN WALL BOXES, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, and J. H. Collings.

The object of this arrangement is to permit the front plate

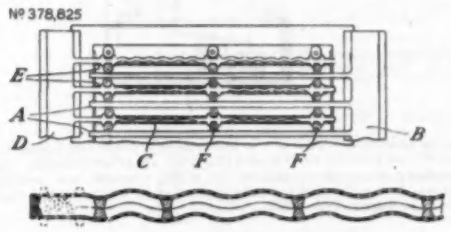


of a flush switch to be adjusted to the face of the wall after the wall box has been set in the wall and to allow of an angular setting also. The switch is mounted on the plate A, which can be rotated about the screw B, by the pillars C, C. These pillars have a screw adjustment, so that the height of the switch can be varied.—*August 18th*, 1932.

ELECTRICAL APPLIANCES.

378,825. March 24th, 1932.—LEAD ELECTRICAL STORAGE BATTERIES, *Britannia Batteries, Ltd.*, 233, *Shaftesbury-avenue, London, W.C.2.*

This invention relates to lead electrical storage batteries and particularly to the negative electrodes or plates of such batteries. According to the invention, the negative electrodes, which are of the so-called box plate type having perforated lead sheets on either side enclosing the active material of the electrodes, are given a wave form in the vertical direction; that is to say, are formed with the troughs and crests of the waves lying in vertical lines, and with the crests and troughs of one sheet in register with the troughs and crests respectively of the other sheet. There are several advantages associated with this construction of negative electrodes of the box plate type. For example, the wood or porous ebonite separators on either side of the electrode bear against the latter only on the crests of the wave structure and are quite clear of by far the greater portion of the surface of the lead sheets, thus increasing the accessibility of the elec-

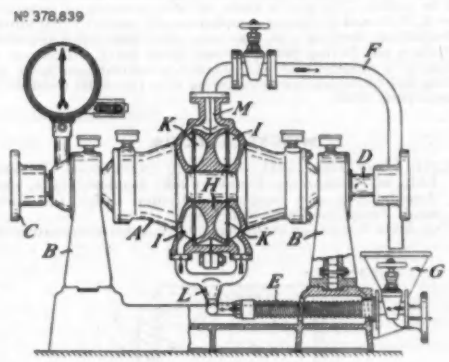


trolyte to the active material contained within the box-shaped electrode. Further, the use of waved or corrugated negative electrodes gives a rigidity of construction which renders these electrodes less liable to buckle than with the ordinary type of negative electrode. As shown in the drawings, A denotes the positive plates of the battery which are integral with or autogenously welded to terminal bars B, while C denotes the negative electrodes of the box plate type which are integral with or autogenously welded to the terminal bars D at the opposite side of the cell. The separators E, which may be of wood or of perforated ebonite sheets or other suitable insulating material, are flat so that they are in contact with the perforated corrugated lead sheet walls of the negative electrodes only at the crests of the corrugated sheets, leaving a substantial space between the separators and the troughs of the corrugations. The crests and the troughs of one plate are in register respectively with the troughs and crests of the other plate. As shown in the drawing, the usual glass spacing tubes F may be interposed between the positive plates A and the separators E.—*August 18th*, 1932.

MEASURING AND TESTING INSTRUMENTS.

378,839. May 7th, 1932.—WATER DYNAMOMETERS, Fried Krupp Germaniawerft Aktiengesellschaft, Kiel-Gaarden, Germany.

The invention relates to water dynamometers intended for the determination of the output of prime movers of the type in which the torque of the prime mover to be tested is communicated to a rotor and is transmitted from thence through the braking water to a casing which is disposed around the rotor and mounted for rotation with respect thereto, the braking water circulating through pockets (preferably of oval cross section) provided in the casing and through co-operating pockets in the rotor. The invention has for its object to eliminate formation of air bubbles in dynamometers of this type and to obviate the necessity of employing special air-removing means, which in any case can only be fitted with difficulty to small dynamometers on account of the confined dimensions of such machines. According to the invention, for the purpose of avoiding air bubbles in the braking water, the latter is supplied to the lowermost braking pocket of the casing and is withdrawn from the casing at the top thereof. A denotes the casing of the water dynamometer, which is pivoted for oscillation about a horizontal axis in bearing



brackets B B. The torque of the prime mover, the output of which is to be tested, is communicated to the dynamometer by means of the clutch member C and is transmitted in the usual way by the shaft D to a rotor H, provided with braking pockets K, and thence by means of the braking water to the casing A, which is likewise provided with pockets I. The result is that the torque transmitted from the rotor H through the braking water to the casing A causes the latter to turn about its pivots. The tendency of the casing to become displaced from its normal position is balanced in the usual way by a system of levers and weights (not shown), and measurement of the weight required to balance the casing enables the output of the engine to be calculated. The braking water working in the pockets K I of the rotor and casing is supplied from below to the lowermost pockets of the casing A through a metal hose E and a bifurcated conduit L, the space between the rotor and the casing thus being filled from bottom to top, so that any air bubbles are expelled from the pockets of the rotor and the casing. The expelled air escapes with the water, the latter being drawn off through the discharge socket M and drain pipe F to a hopper G.—*August 18th*, 1932.

LIGHTING AND HEATING.

378,704. October 19th, 1931.—IGNITION DEVICES FOR HIGH-POWER ARC LAMPS, Carl Zeiss, Jena, Germany.

The object is to strike the arc of large lamps very rapidly—in a period of 0·1 sec. A light auxiliary electrode A is pivoted

at B and can be swung, through the linkage shown by the electro-magnet C. It is provided with current through the lead D and resistance E. When current is switched on the auxiliary electrode is drawn away from the negative carbon and a small

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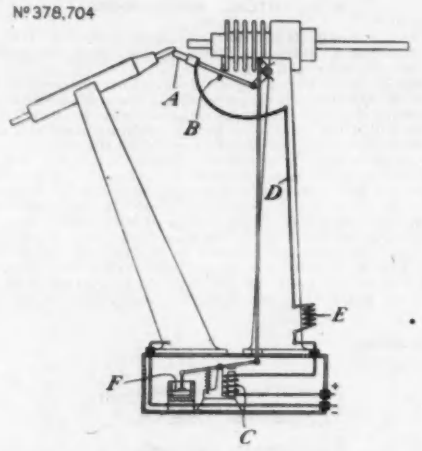

arc is produced. This arc is immediately projected across the gap to the positive carbon and the main arc is established. The auxiliary electrode continues to move towards the positive carbon, but is checked towards the end of its stroke by the dash-pot F.—*August* 18*th*, 1932.

METALLURGY.

378,834. April 16th, 1932.—THE MANUFACTURE OF BARS FROM WROUGHT IRON PILE, The Scottish Iron and Steel Company, Ltd., 53, Bothwell-street, Glasgow; and H. C. Waterston, "Trearne," Queen-street, Helensburg.

This invention relates to the manufacture of wrought iron hoops from a pile of puddled bar, such hoops being used, for example, in the manufacture of welded tubes. The term "hoop" is used to denote a thin bar which has been rolled to approximately the breadth and thickness required to make the tube without being sheared from rolled plate, the thin bar being produced by rolling and simultaneously elongating a re-heated pile of puddled bar. The re-heating and rolling processes employed in the production of the thin bar or "hoop" effect the welding together of the pile of puddled bar. According

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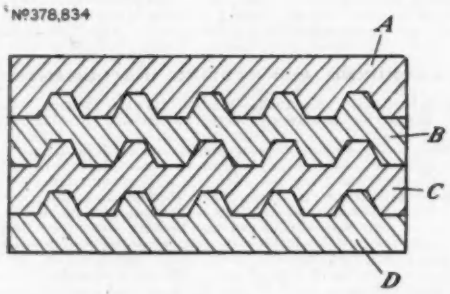

to the invention, the pile consists of layers of indented puddled bar, *e.g.*, a top plate having parallel longitudinal indented grooves, a bottom plate having parallel longitudinal projecting ribs, and one or more intermediate plates having projecting longitudinal ribs on one side and indented corresponding longitudinal grooves on the other side, the whole being welded together by re-heating. The drawing shows in section a form of pile according to the invention, from which wrought iron hoops can be rolled. The pile is made up of a plurality of indented bars A, B, C, and D, having complementary parallel longitudinal indentations, forming ribs, the bars being assembled together to form a pile having flat upper and lower faces. This pile is raised to a welding heat and thereafter formed into hoop by rolling and simultaneously elongating it in the usual manner.—*August* 18*th*, 1932.

MISCELLANEOUS.

378,882. May 13th, 1931.—ELECTRIC INSULATORS, Bullers' Ltd., of 6, Laurence Pountney-hill, London, E.C.4, and Joseph Lustgarten Langton, of Lynton Lodge, Old Hall-road, Broughton Park, Manchester.

This invention is for improvements in electric insulators of

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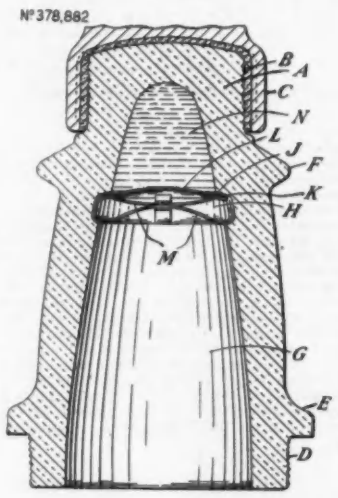

the type in which the insulator is supported from its base and has an open cavity extending from the base towards a closed head, which is arranged to carry an electric conductor such as a bus-bar or isolating switch. When insulators of this type are supported on concrete floors, walls or roofs, they suffer from the disadvantage that moisture and conducting deposits collect in cavities, particularly at the ends adjacent the conductors. If there is a fault in the insulator in the neighbourhood of the head, sparking tends to develop at the patches of moisture and dirt, and eventually the insulator fails electrically. An insulator made in accordance with this invention is characterised in that the head end of the cavity is filled with an insulating material and that the sealing member is arranged to engage the inner wall of the cavity and to secure the material in position. The insulator has a cylindrical portion A at the head. The outside of the head is roughened at B for securing it by means of cement to a metal cap C, which carries the bus-bar. The foot end of the insulator is also provided with a roughened outer cylindrical surface D. A shoulder E is formed at the foot end of the insulator, whilst a small shed F is formed adjacent the cylindrical portion at the head of the insulator. A cavity G extends from the foot end of the insulator to within ¾in. from the top of the head. A circumferential groove H is formed in the inner wall of the cavity. The inner side wall of the groove is flattened at J and receives a cork washer K. A sheet metal disc L is arranged to engage the cork washer and is retained in position by two sets of spring fingers M. Before the disc is inserted in position the inner end of the cavity is filled with insulating compound, indicated at N. It will be appreciated that the employment of a solid or liquid insulating material will prevent sudden electrical breakdown should a crack in the insulator wall develop in the region of the metal cap. Furthermore, a crack will be disclosed by the oozing out of the insulating material and will lead to the detection of a fault in the insulator.—*August* 15*th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Midland District Meeting at Coventry. Assemble at Council House, Earl-street, Coventry. 2 p.m.

TO-DAY TO WEDNESDAY, SEPTEMBER 28TH.

BUILDING EXHIBITION.—Olympia. 11 a.m. to 9 p.m. daily.

SATURDAY, SEPTEMBER 24TH.

ALL-BRITISH EXHIBITION.—Copenhagen, Denmark, Opening.

WEDNESDAY, SEPTEMBER 28TH.

BELFAST ASSOCIATION OF ENGINEERS.—Belfast. Inspection of new laundry, Poor Law Union. 7.30 p.m.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY.—At the Lyons' Angel Café, Islington, N.1. Open discussion, "The Possibilities of Standardising Electro-deposits."

INSTITUTION OF WELDING ENGINEERS: NORTH-WESTERN BRANCH.—College of Technology, Sackville-street, Manchester. "Testing of Welds," by Mr. L. W. Schuster. 7.30 p.m.

THURSDAY, SEPTEMBER 29TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—In the Hall of the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. Presidential Address, by Mr. W. A. Lelean. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. "Salvage Work on the Ex-German Fleet at Scapa Flow," by Mr. E. F. Cox. 7.30 p.m.

SATURDAY, OCTOBER 1ST.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Visit to Kingsbridge and Salcombe Water Board's Works. Meet at South Brent Station, G.W. Railway. 2 p.m.

MONDAY, OCTOBER 3RD.

CHEMICAL ENGINEERING GROUP.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W.1. Jubilee Memorial Lecture, "The Corrosion of Metals in Salt Solutions and Sea-water," by Dr. G. D. Bengough. 8 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C.2. "The Elimination of Reflections from Glazed Pictures in Galleries," by Mr. Robert Howden. 3 p.m.

TUESDAY, OCTOBER 4TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C.2. Presidential address, "Legislation and the Automobile Engineer," by Major C. G. Nevatt. Presentation of awards. 8 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—In the Lecture Room at the Home Office Industrial Museum, Horseferry-road, Westminster, S.W.1. Autumn special meeting. "The Measurement, in Relation to Human Comfort, of the Radiation Produced by Various Heating Systems," by Dr. H. M. Vernon. 6.45 p.m.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—The Education Offices, St. James's-road, Dudley. Presidential Address, Mr. A. E. Osborn. 7 p.m.

WEDNESDAY, OCTOBER 5TH, TO SATURDAY, OCTOBER 15TH.

INTERNATIONAL EXHIBITION OF INVENTORS.—Central Hall, Westminster, S.W.1. 11 a.m. to 10 p.m. daily.

THURSDAY, OCTOBER 6TH.

BIRMINGHAM METALLURGICAL SOCIETY.—At the University, Edmund-street, Birmingham. Presidential Address, Mr. A. A. Jude. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Merchant Venturers' Technical College, Bristol. Presidential address, "Legislation and the Automobile Engineer," by Major C. G. Nevatt. 7 p.m.

ROYAL AERONAUTICAL SOCIETY.—At the Royal Society of Arts, John-street, Adelphi, W.C.2. "Air Navigation," by Captain N. MacMillan. 6.30 p.m.

FRIDAY, OCTOBER 7TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W.1. "Cornwall as a Cradle of Science and Engineering," by Mr. S. J. Crispin. 7.30 p.m.

RAILWAY CLUB.—57, Fetter-lane, Fleet-street, E.C.4. "The Great North of Scotland Railway," by Mr. H. A. Vallance. 7.30 p.m.

MONDAY, OCTOBER 10TH.

ENGINEERS' GERMAN CIRCLE (DEUTSCHER INGENIEURZIRKEL IN LONDON).—At the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W.1. "Der Benson-Hoch-druckkessel (225 atmos.) als Land-und Schiffskessel, Ausführungen und Erfahrungen" ("The Benson High-pressure Boiler, 3200 lb. per Square Inch, as Land and Marine Boiler, Construction and Results"). Illustrated with lantern slides, by Diplom-Ingenieur F. Ohlmüller, of Siemens-Schuckertwerke. 5.15 p.m. for 6 p.m.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—In the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Chairman's Address, Professor Robert Hay. 7.30 p.m.

TUESDAY, OCTOBER 11TH.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-upon-Tyne. Chairman's Address, Mr. A. Logan. 7.30 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—In the Rooms of the Y.M.C.A., Swansea. "Refractory Materials and the Non-ferrous Industries," by Mr. A. B. Searle. 6.15 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. Presidential Address, by Mr. Archibald Gilchrist. Paper, "The M and C System of Time Study and Rate Fixing," by Mr. Sam Mavor. 7.30 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS: ASSOCIATE MEMBERS AND GRADUATES' SECTION.—At the Borough Polytechnic, Borough-road, Southwark, S.E.1. "Some Features of the Manufacture of Malleable Iron Fittings and Cast Iron Radiators," by Mr. C. E. Green. 7 p.m.

WEDNESDAY, OCTOBER 12TH.

DIESEL ENGINE USERS ASSOCIATION.—Caxton Hall, Westminster, S.W.1. "Steel Frames for Diesel Engines," by Mr. C. H. Stevens, 3 p.m.

THURSDAY, OCTOBER 13TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the University, Edmund-street, Birmingham. "Symposium on Hardness Testing." 7 p.m.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W.1. Chairman's Address, Mr. S. L. Archbutt. 7.30 p.m.

FRIDAY, OCTOBER 14TH.

CHEMICAL ENGINEERING GROUP.—At Burlington House, Piccadilly, W.1. "Colloidal or Coal-oil Fuel," by Professor J. S. S. Brame. 8 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. Chairman's Address, "Annealing." Captain F. Orme. 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Grosvenor Restaurant, Glasgow. "James Watt" dinner.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Informal meeting. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W.1. Chairman's Address, Mr. J. Foster Petrie. 7.30 p.m.

MONDAY, OCTOBER 17TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Institution of Engineers and Shipbuilders, 39, Elmbank-crescent, Glasgow. Presidential address, "Legislation and the Automobile Engineer," by Major C. G. Nevatt. 7.30 p.m.

TUESDAY, OCTOBER 18TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: WOLVERHAMPTON CENTRE.—At the Engineering and Scientific Club, Queen-street, Wolverhampton. "Vehicle Springs," by Mr. C. Stirling. 7.30 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS: ASSOCIATE MEMBERS' AND GRADUATES' SECTION.—All-day visit to Works of Crane, Ltd., Ipswich.

WEDNESDAY, OCTOBER 19TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Hotel Metropole, King-street, Leeds. Presidential address, "Legislation and the Automobile Engineer," by Major C. G. Nevatt. 7.15 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS: ASSOCIATE MEMBERS' AND GRADUATES' SECTION, MANCHESTER AND DISTRICT BRANCH.—Engineers' Club, Manchester. Annual dinner. 7 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON): BIRMINGHAM CENTRE.—Room 178, Queen's Hotel, Birmingham. Presidential address, Mr. W. A. Lelean. 6.45 p.m.

NEWCOMEN SOCIETY.—In the Lecture Theatre, Science Museum, South Kensington, S.W.7. "The Site of Newcomen's Engine of 1712," by Mr. T. E. Jones. 5.30 p.m.

THURSDAY, OCTOBER 20TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—In the University, Edmund-street, Birminghan. Lecture by Sir Charles Grant Robertson. 7 p.m.

ROYAL AERONAUTICAL SOCIETY, Joint Meeting with the Institute of Rubber Industry.—At the Royal Society of Arts, John-street Adelphi, W.C.2. "Flying Conditions on the West Coast of Africa," by Flight-Lieutenant W. G. Pudney. 6.30 p.m.

FRIDAY, OCTOBER 21ST.

INSTITUTION OF MECHANICAL ENGINEERS.—At Connaught Rooms, Great Queen-street, W.C.2. Annual dinner. 6.45 p.m. for 7.15 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W.1. "Notes on Windmill Construction," by Mr. Rex Wailes. 7.30 p.m.

SATURDAY, OCTOBER 22ND.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS: ASSOCIATE MEMBERS' AND GRADUATES' SECTION, MANCHESTER AND DISTRICT BRANCH.—Visit to Mersey Tunnel, Liverpool.

MONDAY, OCTOBER 24TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C.2. Discussion, "The Future Prospect for Electrical Engineers." Opener, Professor E. W. Marchant. 7 p.m.

TUESDAY, OCTOBER 25TH.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—39, Elmbank-crescent, Glasgow, C.2. "A Note on the Development and Operating Results of 'Bauer-Wach' Installations," by Mr. R. J. Butler. 7.30 p.m.

WEDNESDAY, OCTOBER 26TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Engineers' Club, Albert-square, Manchester. Presidential address, "Legislation and the Automobile Engineer," by Major C. G. Nevatt. 8 p.m.